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A Maximal Pack Test of Exercise Tolerance

By Craig Taylor

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Stanford University, California

(Submitted for publication September, 1944)

THE need for a test of fitness and endurance in heavy physical exertion that can quickly be applied to large groups of men with varying ages and physical capacities often arises in dealing with such problems as the effects of physical training, and classification of men for strenuous duty. Most commonly used are the athletic performance tests, which consist of batteries of such events as pull-ups, push-ups, sit-ups, pick-a-back races, broad jumps, and distance runs.[1] Men, unused to athletic competition and not skillful in such activities often obtain scores which do not truly represent their exercise tolerance. Elements of total body fitness and endurance are estimated in races of 300 to 440 yards, but the knowledge of how to run such a race is a factor in the performance, and the practice of subjecting older men, 30 to 45 years of age, many of whom have held sedentary jobs for years, to such competition under the pressure to succeed entails an unnecessary and unwarranted hazard to their health. These considerations led the writer to investigate the possibility of a test which will (a) measure the essential qualities of exercise tolerance without dependence upon athletic skill and knowledge; (b) not involve competitive racing; yet (c) be adaptable to large-scale testing.

After some preliminary experimentation with rates of work, height of bench, amount and spacing of loading, and type of muscular movement, the following test was devised:

THE EXERCISE

Ascent.—The subject stands before the bench with left foot on the bench, and left hand grasping the crossbar.[2] On the first count

The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and Stanford University. The author wishes to acknowledge the assistance of Guy Brown, Frederick Crescitelli, Bernard Hansen, and Royce Skow. The author is at present Lieutenant, AC, Biophysics Branch, Aero Medical Laboratory, Wright Field, Ohio.

1 See for example, Training Circular No. 87, War Department.

2 The bench must be 18 inches high, about 14 inches wide, and long enough to give stability. The crossbar is placed directly over the back edge of the bench with its upper edge 6 feet from the floor. Usually a cleat on the wall will serve this purpose if spaced to allow a finger hold.

he raises himself to a stand on the bench by the combined flexion of the left arm and thrust of the left leg. The right foot pushes off and is touched on the top of the bench at full ascent; the right arm is unused. The subject must come to a full vertical stand on the bench, and must flex the pulling arm.

Descent.—The right foot is taken off the bench and started for the floor, while the left arm and leg exactly reverse the course they took during ascent so that subject comes to initial position standing on right foot. Left arm and leg maintain their positions on bar and bench between ascent-descent cycles. These cycles are carried out at the rate of 40 per minute to a metronome or other cadence sounder, and in a few seconds the subject learns to carry out the maneuvers smoothly and to cadence.

Every half-minute the examiner gives the signal to change, at which the subject switches to work right leg and arm just as described for the left. If the command to change is given early during ascent, this change can be made at the top of the ascent without disturbing the rhythm. Thus, the subject works one side of the body at a time, alternating right and left sides every half-minute.

Endpoint of the test.—The subject continues the work until he can no longer execute full ascent-descent cycles at the proper rate, that is, until fatigue limits the performance. As the work progresses there is a gradual accretion of general fatigue, and the recovery of each arm and leg pair during its inactive phase is less complete. The subject will be observed to show greater and greater difficulty in carrying on, and his voluntary termination of the work, accompanied by signs of exhaustion (see below), may be accepted as evidence that his true endpoint has been reached.

Post-exercise heart rate.—This may be obtained by palpation of the radial or carotid pulses,[3] or by stethoscope at the chest wall. Either of the last two methods are preferable to the first. The heart rate is counted for 20 seconds beginning ten seconds after the termination of the work.

Loading the subject.—During the warmup an unloaded packsack is worn, but a 10 pound weight[4] is added before beginning the test. Ten-pound weights are added each two minutes thereafter, as long as the subject continues the test.

SCHEDULE

1. Preliminary minute of work for warmup and practice, subject unloaded.

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3 The carotid pulse is obtained by standing behind the subject and placing the finger tips just to the side of the larynx.

4 These weights may be of any sort, although we have found 10-pound sandbags to be very satisfactory.

2. Interim rest, 15 seconds. Add weight.

3. Test. Working side of the body changed each half-minute. Weights added at 2, 4, 6, and 8 minutes without interrupting the work.

4. Endpoint. Time from beginning of test is recorded.

5. Heart rate. 10 to 30 seconds after end of work.

This rather unique form of exercise was selected because it brings all but exceptionally strong men to exhaustion within ten minutes without excessive loading. Though the muscular activity is roughly limited to one arm and leg at a time, the muscle mass brought into play is sufficiently great to create a general fatigue as well as local exhaustion of the neuro-muscular apparatus. The arm action also brings into the test the strength, endurance, and toughness of the shoulder girdle and torso muscles, so that together with the legs the whole body is vigorously exercised.[5]

EVIDENCE OF THE VALIDITY OF THE TEST

While the maximal pack test depends chiefly on "face validity," that is, the length of time a man can work before becoming exhausted is self-evidently a criterion of his fitness for hard physical work, additional observations and comparisons attest to its validity.

1. A comparison has been made between scores made by two groups of college men selected on athletic performance scores.[6] Ten men who ranked in the upper ten per cent of the student body in athletic tests constitute a "high" group, and ten men from the lowest ten per cent, a "low" group. The data follow:

	High Group		*Low Group*		*Difference*		
	M	S	M	S	M	t	P
Maximal pack test	535.	69.	259.	70.	276.	8.61	< .001
Johnson-Brouha test	83.4	7.3	67.6	11.7	15.8	3.17	.005

It is clear that the maximal test differentiates these groups very well when judged by mean difference and lack of overlap in scores, and by *t*. The Johnson-Brouha test distinguishes the groups about one-third as well.

2. From continuous heart-rate records taken by electrocardiotachometer during these tests it was found that, in general, the heart rate response to the maximal exercise resembles that found in the maximal treadmill test[7] where the heart rate has been found to be a

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[5] Mr. J. C. Winterburn of the Menlo Junior College has found this form of exercise, carried out on stall bars, to be a very useful conditioning exercise for physical education classes. No load is necessary when it is used in this way.

[6] An athletic performance battery consisting of pull-ups, push-ups, sit-ups, standing broad jump, 6-second run, shuttle run, and 300-yard run. Standard scores in these events are added to give a physical fitness score.

[7] A study by the author, 1944.

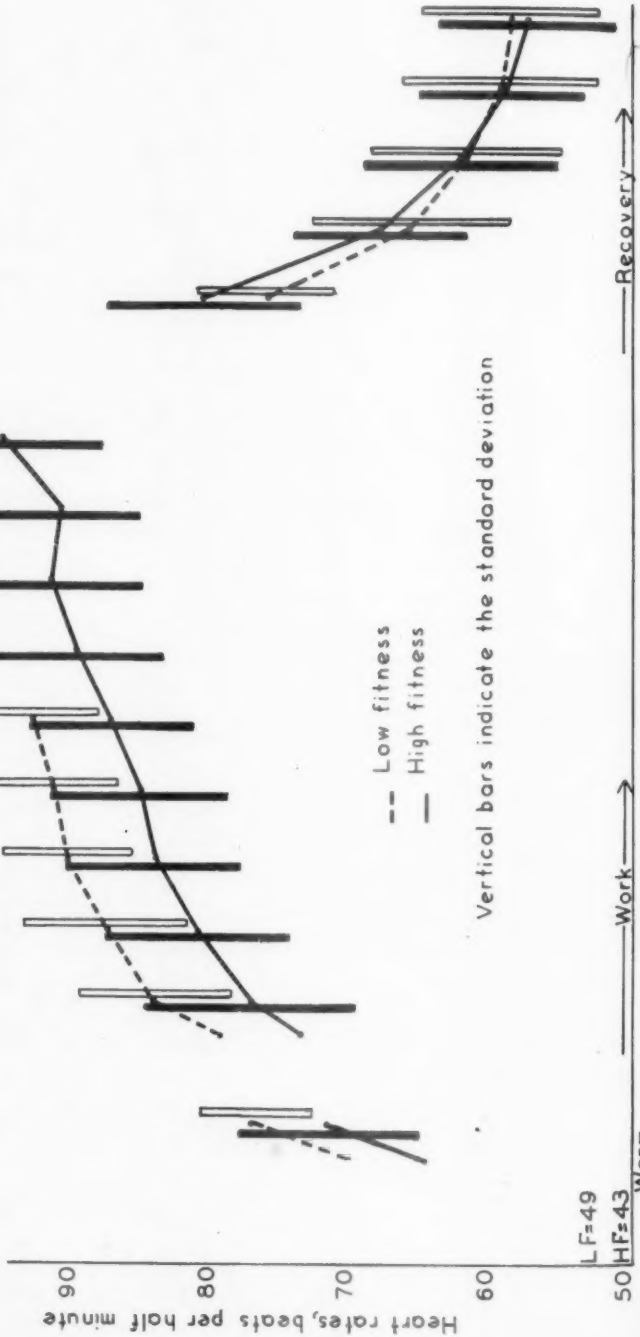

FIGURE 1. PACK TEST HEART RATE

highly reliable and valid correlate of time-to-exhaustion. The more fit the subject the slower the approach of heart rate to maximal levels (M = 186 beats per minute). Mean curves for the high and low groups are given in Figure 1. The terminal heart rates, which vary from 178 to 206 beats per minute in this series do not correlate significantly with time-to-exhaustion ($r = .18$), indicating that both weak and strong subjects tended to reach about the same terminal heart rates. Thus, the time to reach this condition of exhaustion is the essential variable.

3. Maximal pack-test scores and athletic test scores on another sample of college students (N = 35) are shown on a scattergram (Figure 2), revealing an interesting relationship which would be masked by simple correlation. While men making good pack-test scores did not necessarily achieve good athletic scores, no one obtained a good athletic score unless he achieved a high pack-test score. This suggests that the pack test measures an ability to carry out heavy physical activity, but not the athletic skill and coordination demanded in the performance test. It is therefore an exercise tolerance test in relatively pure form.

4. Test and retest on 10 college men before and after a ten weeks' participation in a special physical education class devoted to heavy physical training show that the pack test will adequately detect the effects of such training. The mean training gain was 75 seconds. Expressed as the ratio: mean difference/standard deviation of the pretest distribution; we have 75.5/99.6 = 76 per cent.

FIELD APPLICATIONS

The first series was carried out on 435 men varying in age from 18 to 46, but all normally active and healthy. Post-exercise heart rates were not taken in these tests, and there were several reasons for believing that many of the subjects did not extend themselves sufficiently to obtain valid time scores. In spite of this, the data are of considerable value, and the following correlations were computed: age-time ($r = -.33$); height-time ($r = .28$); and weight-time ($r = -.01$). It is remarkable that no significant correlation was found between body weight and score even though the same weights were borne regardless of the size of the subject, but scores were slightly better in taller and younger subjects. As a result of this experience, it was decided to incorporate the post-exercise heart-rate count, not only as an additional motivating factor, but also to give a basis for judging whether the subject "puts out."

The final series of tests include the post-exercise heart-rate count in all cases, and were made on 109 college men, and 192 additional unselected men. Some data on the composition of the groups are:

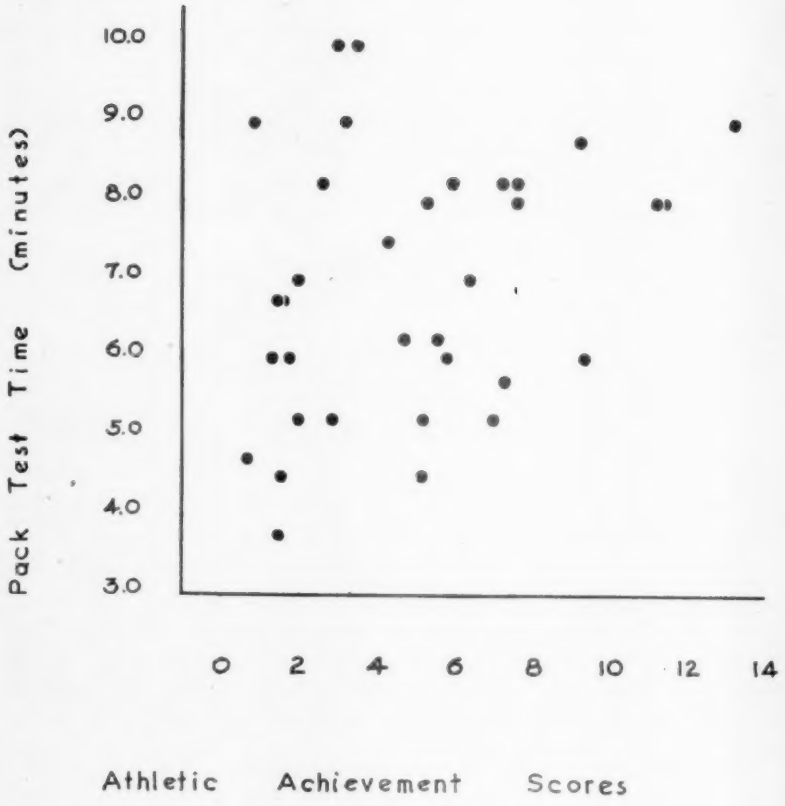

Figure 2.

	College Group			*Unselected Men*		
	M	S	Range	M	S	Range
Height (in.)	70.7	2.53	64-77	69.8	2.55	62-77
Weight (lb.)	159.0	17.6	116-200	167.1	19.6	116-215
Age (years)	18.7	1.3	16-23	25.8	6.2	18.47
Score (min., sec.)	6'44"	1'38"	2'-10"	3'43"	1'34"	1'-8'30"

The college group is about the same height, but lighter and younger than the unselected group. Its average score was almost twice that of the unselected group.

As a first step in the analysis, correlations (height-score and weight-score) were computed to determine whether handicapping for height and/or weight would be necessary. A preliminary scattergram of score against age (301 cases) showed a considerable nega-

tive relationship. Accordingly the data of the college group, wherein the age range was narrow and score was uncorrelated with age, were used in order to eliminate the age factor as a variable. The coefficients of correlation were: height-score, .36; weight-score, .15. Partial correlations were found: height-score (weight), .33; and weight-score (height), .06. These show that weight has no significant effect apart from height, and it was decided that handicapping would be justified only for height. The unselected cases were then added and an r of .32 obtained between height and score. The regression of score on height, calculated in the conventional way, was found to equal 16 seconds for each inch in height. Thus, a man of average height (70 inches in our groups) would receive no handicap, but taller men would have 16 seconds subtracted from their time score for every inch of height over 70. Shorter men would receive additions to their scores in the same ratio. The scores tabulated in Table I are height-equated times-to-exhaustion.

Since the number of men over the age of 25 was rather small, the scores were grouped in seven age intervals as shown in Table I. The tendency for mean score to diminish with age is clear though the sampling is scanty in the older groups. Post-exercise heart rate, however, declined only moderately with age, corresponding reasonably with the trend of maximal heart rate with age found by Robinson (1938) in treadmill experiments. In his subjects there was an average drop in maximal heart rate of about 10 beats per minute over the age range 20 to 40. This compares with a 12-beat decline over the same range in our data. One may conclude from this that the lower post-exercise heart rates with age indicate an age change rather than failure of the older subjects to push themselves to the exhaustion endpoint.

NOTES ON SCORING

No valid way has been found to combine post-exercise heart rate in the score. Nevertheless it is a useful adjunct to the test in two ways: (a) It serves as a motivator. If the subject knows that the examiner has an independent check on his performance, he is much more liable to "put out." (b) It gives the examiner a basis for judging whether or not the performance of the subject has been wholehearted. Good performance is best assured when the subjects have been told that they must work to the exhaustion endpoint, and by requiring retests if in the judgment of the examiner they have not done so. A performance may be judged inadequate if:

1. Subject stops before there is evident difficulty in maintaining the rate or coming to full stand at the top of the ascent each time.

2. Signs of dyspnea or other outward evidence of stress are lacking.

TABLE I

FIELD APPLICATION DATA BY AGE GROUPS

A. Post-exercise Heart Rate

H.R./20"	17	18-21	22-25	26-29	30-33	34-37	38-46
70							
68		2	1				
66	1	6	3	1			
64	2	26	6	4	2	1	
62	7	28	20	4	3		1
60	4	32	8	5	4	2	2
58	3	19	11	5	5	1	1
56	1	17	8	2	2	1	
54	2	6	2	1	3	4	2
52		4	3	1	1	1	
50		1		3			2
48					2		1
46			1				2
44						1	
Mean H.R.	61	61	61	59	59	57	56

B. Score (height equated time)

10:	1						
:30							
9:		5					
:30	4	4	1				
8:	2	8	2				
:30	1	7					
7:	1	11	2				
:30		11	3				
6:	2	13	3		1		
:30	1	18	4				
5:	2	13	7		2		
:30	3	11	5	2	1		
4:	2	13	8	5	3	1	
:30		5	12	4	3	1	1
3:	1	7	4	4	5		
:30		11	9	2	3	4	1
2:		2	2	6	1		4
:30		1		3	1	4	2
1:		1			2	1	2
:30			1				
Mean	6'28"	5'30"	4'24"	3'02"	3'19"	2'22"	1'57"
N	20	141	63	26	22	11	11

3. Post-exercise heart rate is low.

Regarding the third criterion, there is unfortunately too much individual variation in rates to justify a formation of a mathematical relationship with score. From the distribution of post-exercise heart rates (Table I) one may estimate the probability that a man has duly exerted himself according to the following: Post-exercise heart rate

under 50 (20 second count), "not acceptable"; 51 - 54, "questionable"; 55 - 58, "below average." While rates may range above these from 60 to 70 the writer knows of no basis of interpretation for them.

A scoring scale, with height corrections, is provided in Table II.

TABLE II

SCORING SCALE

Time	*Points*	*Frequency**	*Time*	*Points*	*Frequency**
10:	100	1	5:	50	22
:30	95	0	:30	45	19
9:	90	5	4:	40	23
:30	85	9	:30	35	17
8:	80	12	3:	30	12
:30	75	8	:30	25	20
7:	70	14	2:	20	4
:30	65	14	:30	15	1
6:	60	18	1:	10	1
:30	55	23	:30	5	1

* Frequency of occurence in age 17-25, field study.

Height correction:

Ht. (in.)	Correction (Points)
76-75	—15
74-73	—10
72-71	— 5
70	0
69-68	5
67-66	10
65-64	15

It is based on the combined data for the ages 17 to 25 where no correction for age seems to be necessary. The score distribution is of approximately normal form and covers practically the whole range of time up to 10 minutes. Since the mean is at 5′15″ the arbitrary scale of scores seems adequate to the data.

DISCUSSION

The maximal pack test depends for its validity upon the simple argument that the duration of working time is the measure of work tolerance. Recently Johnson, Brouha, and co-workers have presented a series of tests in which the duration of work (treadmill running, stool stepping with and without packs) is a positive element in the score, and heart rate is a subtrahend or denominator in the score.[8] A further innovation is provided in that duration of work is limited to five minutes, thus making the test maximal for weak subjects who cannot continue this length of time and submaximal for strong sub-

[8] Recovery Index = $\frac{\text{Duration of exercise (seconds) X 100}}{\text{2 (Sum of pulses (1-1½) (2-2½) (4-4½) minutes of recovery)}}$ 1942(b)

jects who complete five minutes and are stopped at this time. Since our experience with this test led to the present modification, it is pertinent to examine results obtained with the Johnson-Brouha test.

Thirty-four healthy but otherwise unselected college men were given Johnson-Brouha pack tests. It was found:

1. The test does not differentiate nearly as well in the upper range of scores where the test is submaximal as it does in the lower ranges where it is maximal. This may be shown by comparing mean scores and score components of our 34 subjects divided into three groups: high, medium, and low, on the basis of maximal pack scores. Means, standard deviations, and measures of the significance of difference between the group means (Fisher's *t*) are given in Table III.

TABLE III

JOHNSON-BROUHA PACK TEST DATA

A. Group statistics

Measures	*High Group*		*Measure Group*		*Low Group*	
	M	S	M	S	M	S
Max. Pack Score	576.1	28.9	404.1	32.8	267.9	40.1
Johnson-Brouha						
Duration	300.0	0.00	292.6	18.6	236.7	72.2
of 3 pulses	357.4	32.1	379.8	27.3	372.0	45.4
Test score	84.4	8.3	77.4	9.1	63.0	18.3

B. Significance of difference among groups

Measures	*High-Medium*		*Medium-Low*	
	t	P*	*t*	P*
Max. Pack Score	13.0	.01	8.8	.01
Johnson-Brouha				
Duration	1.3	.10	2.5	.01
of 3 pulses	−1.8	.05	.5	.33
Test score	1.8	.05	2.4	.01

One would expect *t*'s to be higher for the maximal pack test than for the Johnson-Brouha score because the groups were selected on the former, but the essential weakness of the Johnson-Brouha test is exhibited in the lower *t* for the high-medium difference compared with the *t* for the medium-low comparison. This effect is even more strikingly shown in the treadmill data of these authors (1942a) although one must judge from mean differences because measures of significance of differences are not supplied. It is also shown by the differential training gains on the "step test" (Brouha *et al*, 1943). In this investigation inter-individual training gains are smaller among the higher scoring groups, corresponding to the present lesser inter-

* Probability that a difference of this magnitude and sign will be exceeded through chance variation.

individual differences between subjects in the upper range of scores. These facts mean that the Johnson-Brouha tests lose validity as they become submaximal. Since in average unselected groups of young men in the age range 18 to 24 at least two-thirds of them find it submaximal (25 of our 34 subjects), the test is weakest where most used.

2. The heart-rate component in the score has no independent validity when the test is maximal. This is shown by the insignificant *t* between mean heart rates for the medium and low groups (Table III), and may also be found in the average figures of Johnson, *et al* (1942a). It has been shown above, furthermore, that maximal heart rate does not correlate with duration of effort in the maximal pack test. Thus, when a performance criterion, such as duration of effort in running or stool-stepping, is allowed to vary, heart rate tends to reach a ceiling value which is uncorrelated with fitness.

3. The heart-rate criterion is of very limited validity when the test is submaximal. This has been shown under (1) above. Actually, Johnson and Brouha require that three pulse counts be made during the first five minutes of recovery, in order to indicate the rate of recovery. That the latter two pulses are "deadwood" may be shown by correlating the Johnson-Brouha "recovery index" computed in the recommended way with one in which the latter two pulses are omitted. In our 34 cases the *r* is .99.

In general, these findings support the view that the Johnson-Brouha tests are valid as long as they are maximal, but of very limited value when submaximal. The author has published (1944) and unpublished data to show that the correlation between submaximal heart rate and a criterion of fitness does not consistently excede .5, and this is why these tests fail in the submaximal range, as shown by the foregoing analysis.

SUGGESTIONS FOR MASS TESTING

Subjects may be tested in groups limited in size only by facilities and observers. Bench and bar space for each subject should be about 30 inches. Three ten-pound bags should be allowed per subject. An amplified cadence sounder will serve for large groups. One observer to instruct the subject, tend to his pack and performance, keep his score, and count his pulse, is required per subject for small groups but something less than this number will suffice for large groups by dividing responsibility.

SUMMARY

A pack test of exercise tolerance which is maximal for practically all subjects is described. This test has the advantage of simplicity and ease of administration to large groups in a short time. In this

respect it is superior to any existing submaximal tests which lose validity when shortened and over-simplified.

In preliminary experiments it was found that heart rates increase during the test in much the same way as found in the exhausting treadmill run, though they do not reach as high maximal levels. For this reason, the maximal pack test may be characterized as somewhat more "muscular" in nature than the treadmill run where cardio-respiratory capacities are paramount.

Field tests on 700 men, ages 16 - 46, have yielded the following results:

1. Performance (time to exhaustion) is independent of body weight but is slightly favored by body height.

2. The decline in performance with age is very marked.

3. A post-exercise heart-rate count aids materially in motivating the subject to "put out" and enables the examiner to check on the adequacy of the subject's performance.

4. A training study over a period of 10 weeks shows that the maximal pack test will detect the changes brought about by physical training.

The present evidence is that the maximal test is more valid than a submaximal test, and is completely feasible for mass administration. It is preferable to the athletic-type fitness test in that athletic skills are at a minimum, and the psychological situation of competitive racing is absent. For this reason it is especially recommended for wide age ranges.

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An Evaluation of Health Practices In Interscholastic Athletics for Boys in Illinois

By

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(Submitted for publication June, 1944)

THE PROBLEM

THE problem was to evaluate the existing health practices in interscholastic athletics for boys in Illinois and to develop policies or procedures for use in the schools.

THE NEED

A definite need for such a study is apparent. Leaders in athletics, in education, and in health and medicine have long been aware of the discrepancies which exist between the theory of health as taught in the classroom, and the practice of health as carried on in the gymnasium, swimming pool, locker and shower rooms, and on the athletic field. Authoritative information concerning conditions and standards has been lacking. Finally, the existing war emergency, which focused new attention on the startling lack of fitness of the youth of America, makes greater emphasis on health and improved health practices in athletics desirable and essential.

The principles of health and hygiene have been known and publicized for many years. Most, if not all, of them have been taught in health classes, both in the elementary and secondary schools. The development of attitudes and ideals of health, however, which would mean the use of these principles as habits, has not kept pace. The result of much health education has too often been memorization of principles and rules, with little or no resultant acceptable change in behavior.

THE PROCEDURE

Maintaining health, and especially the health of participants in athletics involves many factors. The school cannot be expected to control, or even affect some of them.

A brief summary of a dissertation accepted in partial fulfillment of the requirements for the degree of Doctor of Education in the School of Education of New York University, June, 1944.

For the purpose of this study, the elements which are concerned with the health of participants and under the control of the school, were determined by submitting questions to professional teachers, coaches and doctors, and substantiating their judgment by that of the jury of fifteen experts who determined the final list of standards to be used in measuring present practices. The jury consisted of five doctors of medicine, five doctors of public health, and five health education experts who met specific training and criteria as to experience in their respective fields as well as interest and knowledge of health problems in athletics. One hundred and one standards were validated by the expert jury.

A check list was developed with the standards as the basis and used to secure information from administrators, coaches, and custodians relative to the health practices in athletics.

Finally the existing practices were evaluated by comparison with the standards, policies were developed, and implications and recommendations determined. The standards and the policies are omitted from this article, because of lack of space.*

THE SURVEY

Six hundred and seventy-two schools, including six hundred and fourteen public schools and fifty-eight private schools, were sent copies of the check list, which was based on the standards, and which was accompanied by a letter of explanation. The information sought was data concerning present health practices in interscholastic athletics.

The selection of schools was made from the Illinois High School Directory, 1942-43, and included only those schools which had an enrollment of seventy-five or more, and which graduated pupils.

Replies were received from four hundred and twenty-eight schools, or 63.6 per cent which included four hundred and two public schools and twenty-six private schools. Four hundred and fifteen of the replies were usable. Inasmuch as there were so few private schools responding, and they varied little if at all from the great majority of the public schools responding, they were not included in the tabulations. Their similarities in practice were overwhelmingly predominant, while their differences were almost non-existent.

THE RESULTS

The study indicates the first important health element in athletics is embodied in the training, experience, and attitude of the coach. He is responsible for evaluating the day-by-day status of the par-

* Readers interested in examining these are referred to the November issue of *Scholastic Coach* for the standards and the December issue of that magazine for the policies.

ticipants; he administers first aid, cares for minor injuries, and inspects the athletic equipment for correct fit and use. Where systematic provision for teaching certain health facts to athletes is made in addition to the required course in health, the coach is listed by three-fourths as the instructor. In schools where individual diets are recommended for athletes, such recommendations are made by the coach in two hundred and twelve (75 per cent) of the schools.

The study shows further that the coach plans every scrimmage, arranges schedules in all sports, and has a closer, more intimate contact with the athletes than any other person. It is apparent that he is one of the most important individuals in the school system, especially with regard to his influence on the participants, directly, and all other pupils, indirectly.

Selection of participants, and the amount of practice and scrimmage were other elements studied. Ability, condition, experience, size, strength, age, grade in school, and attitude, are the main criteria used in selecting members of varsity teams. Practice periods before the first scrimmage vary from none to thirty in basketball, and two to twenty-eight in football, with eight or nine the average in both sports and fourteen the average before scheduled contests in each one. Football practices average two hours and three minutes, including showers and dressing, and basketball practices average one hour and forty-one minutes.

The number of games scheduled for each sport is another element which affects health. Two hundred and thirteen schools (70 per cent of those answering this question) indicated fewer games in basketball during 1942-43, but forty stated "more." Other sports were as follows:

	Less	*More*
Track and field	101 schools	16 schools
Baseball	75 schools	13 schools
Football	66 schools	17 schools
Wrestling	18 schools	3 schools

Ninety-one schools failed to answer the above question; twenty indicated they were not certain as to spring schedules when they returned the inquiry blank late in February, 1943. The average number of games or meets scheduled in varsity sports was as follows: basketball, 19; baseball, 8; football, 7; and track and field, 6.

The data revealed that the school team physician gives the health examination in 60 per cent of the schools responding, while the family physician assumes the responsibility in the remaining schools. One-fourth of the schools require seasonal examinations, while the remaining ones require an annual examination. While 60 per cent of the schools indicate they have a formulated policy regarding financial responsibility for injuries incurred in athletics,

only half of this group made a systematic effort to inform the parents concerning such a plan.

One hundred and forty-eight schools (37 per cent) provide clean towels daily for the individual participants. This is financed by a fee in one third of the schools, and by the board of education or the athletic association in the remaining institutions.

Another element studied was equipment. Personal equipment is provided by the participant in the small schools, and by the athletic association or the board of education in the rest. The balance of the uniform and all protective equipment is provided by the athletic association or the board of education, with the possible exception of shoes in many small schools. The participants have the responsibility for cleaning their personal equipment, except in the larger schools, where the board of education or the athletic association assumes the responsibility. The method of cleaning personal equipment is not satisfactory, except in the large schools where this is done either in the school laundry, or in a commercial establishment. The method of cleaning practice equipment is satisfactory, for the most part, but the frequency is not, in 80 per cent of the schools.

The all-round picture of the janitorial controls is poor in all but 15 per cent of the schools. Both the method of cleaning and the frequency do not meet approved standards. Whether this is due to lack of training on the part of the janitorial staff, or too many demands on their time, is not apparent from the available information.

When the administrators were asked to evaluate their own situation in terms of inadequacy, as shown by the presence or absence of certain controls, 55 per cent of the schools placed inadequate medical controls first, and 26 per cent mentioned inadequate facility controls. In every case, the response to this section substantiated information received from other parts of the inquiry blank.

When the health practices in athletics, studied in the survey, were measured by the standards previously established, it was found that three-fourths of the schools responding met fifteen (21 per cent) of seventy-one standards. No questions were asked specifically concerning thirty additional standards, but data elsewhere in the study indicated that as many as seven of this group are met in three-fourths of the schools. Thirty per cent of the standards are therefore met by a majority of the schools sufficiently to be listed in this category. Even in this group, however, there were individual instances, where schools indicated excellent practices in one or more of the controls, and average or poor practices in the others.

CONCLUSIONS

The study indicates that the situation with respect to health practices in interscholastic athletics in Illinois is poor. This is espe-

cially true in many small schools, and in some large, over-crowded institutions. Too little attention has been given this vital side of athletics. Specific conclusions concerning a majority of the schools responding are as follows:

1. Medical controls are inadequate and this tends to hinder or even negate improvements which might be made in other areas.

2. Safe and adequate personal, practice, and game equipment is not provided for all participants.

3. Training and conditioning programs are not adjusted or modified to meet the needs of individual participants.

4. The gymnasium, shower, and locker rooms are not cleaned frequently enough, nor with adequate methods and approved materials to eliminate hazards to health.

5. Other aids to cleanliness and health, such as warm water, liquid soap, and paper and individual towels are not provided.

6. The cleaning of personal and practice equipment is so infrequent and haphazard as to constitute another health hazard.

7. The training of coaches, particularly in health practices as related to athletics, is inadequate.

8. Adequate facilities for instilling or encouraging good health practices in a comprehensive program of athletics and a modern curriculum in physical education are lacking.

The data indicate, further, by inference that:

1. Coaches are not selected with the care that their positions merit.

2. Functional courses in health are lacking and adequate supplementary instruction is not given participants in athletics.

3. Existing school and community facilities for athletics are not used as fully or as efficiently as they should be used.

4. Administrators are not alert to their responsibilities in connection with improving the health situation by securing capable, well educated coaches who are aware of, and sympathetic toward the problems involved. The same responsibility exists for securing capable, well trained custodians.

5. Boards of education are not sufficiently aware of the objectives of athletics, and the many problems connected with the health of the participants to be willing to provide the necessary funds for securing the right personnel and improving the facilities.

The adequacy of the program and the contribution to the individual participant is determined by the educational philosophy of those who administer the school. The administrators and the school board determine the direction and the scope of the program, the

safety and the health measures which can and should be employed, and the outcomes of athletics, by the care with which they select the coach, and the vision they display in making appropriations for salaries, equipment, facilities, and adequate maintenance of the physical plant.

IMPLICATIONS AND RECOMMENDATIONS

Progressive boards of education, and modern administrators are always more concerned with the type of person the prospective coach is, and the adequacy of his training, than with the number of letters or other athletic honors secured in college. They likewise recognize that the position of custodian demands just as careful selection as any other position in the school system. Unfortunately, not all school board members and administrators can be included in this progressive group.

1. School board members and administrators should participate in a series of discussions concerning the objectives and desirable outcomes of athletics when conducted on a high educational plane. This should ultimately result in the adoption of a code of athletics, or a set of policies to serve as ultimate goals for a specific school.

2. School board members and administrators should consider plans for paying salaries to coaches which are commensurate with their training and experience, and their actual contribution to the individual participants, the rest of the school enrollment, and the community.

3. School board members and administrators should visit the athletic laboratory from time to time during practice and contests, to see first hand, how closely or how loosely the objectives are considered by those responsible for the administration and teaching of athletics.

4. School board members and administrators should consider plans for improving or expanding the facilities available for athletics and the curriculum in health and physical education.

5. Every coach whose training is inadequate should improve and increase his educational qualifications. They should make use of the opportunities provided by institutions of higher learning, either through extension courses or summer work, so that they may have a greater share in making a substantial contribution to the health and welfare of the participants in athletics.

6. The standards developed in this dissertation and the policies which grew out of them, should be made available to principals, school board members, coaches, and teachers of physical education.

7. Each of the controls or areas studied in this dissertation should be expanded, and studied more comprehensively, and in

greater detail, by state and national groups. Comparisons and differences between schools in various sections of the state, and with different states would be of value in improving the conduct of athletics, particularly as related to the health of the participants.

8. The cooperation and wholehearted support of coaches, administrators, school board members, physicians, custodians, parents, townspeople, and participants are necessary to insure the development of a good program. Educational public relations will help secure both the moral and financial support necessary to initiate and carry on a program which will result in all schools approaching and eventually reaching adequate standards for health practices in athletics.

Did The Greeks and The Romans Play Football?

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(Submitted for publication, January, 1944)

THIS investigation was prompted by a statement in Coyer's *The Coaching of Soccer* that *harpastum*, a handball game of the Greeks, was developed by the Romans into a game in which the ball was kicked, thus becoming one of the forerunners of soccer. Coyer states that the Greek word *harpaston* is derived from a word meaning *to hurl forward*. The latest edition of the Liddell and Scott Greek Dictionary does not recognize such an etymological explanation. The word comes from the Greek word meaning *to seize* or *to grasp*. The dictionary mentioned immediately above gives the word as a neuter substantive of an adjective *harpastos*, meaning *carried away*.[1]

Scholars have, from time to time, attempted to find evidence as to whether or not the ancients played football. Two notable illustrations are Koch's *Die Geschichte des Fussballs im Altertum und in der Neuzeit*, which Keller finds to offer highly problematical positive evidence; and Becq de Fouquieres, in *Les Jeux des Anciens*, who, however, cites no authority for his statement. In this paper I have not endeavored to survey all Greek and Latin literature for references to ball games or even to look up all references to ball games as indicated in existing *Indices* and *Concordances*. I have, however, in an effort to clarify our conception of *harpastum*, studied in the original sources the references listed in the two chief encyclopedias of antiquities, the *Real-encyclopadie classischen Alterumswissenschaft* and the *Dictionnaire des antiquites grecques et romaines*.

The word *harpastum*, in addition to the conjecturable etymology referred to above, offers another problem. The dictionaries, both Greek and Latin, define it as a handball. References in literature refer to it both as a handball and as a ball game. Whether the ball derived its appellation from the game or whether the game derived its appellation from the ball is a moot point. It is known, however, that the Greeks not only did have a "word for it" but even had

1 Coyer further states in this connection that the word *harpoon* has the same root as *harpastum*. This explanation is erroneous, for the word *harpoon* is derived from a French noun and verb meaning *claw* and *to grapple*.

"two words for it." Athenaeus, a Greek scholar of the second and third centuries, A.D., tells us that *harpastum* was originally called *phaininda;* Clemens of Alexandria, a Father of the Church at the same time, that it was originally called *pheninda;* Eustathius, an archbishop of Thessalonica in the twelfth century, that it was originally called *phaininda.* Evidence to support the fact that *harpastum* and *phaininda* were the same game is that both Athenaeus and Pollux so identified the games and that no writer mentions the games as being distinct from each other. In addition, Athenaeus refers to the ball game, which was then called *harpastum* and which formerly had been called *phaininda,* as being the kind of ball game he liked best of all, which statement would seem to indicate that he had more than an academic interest in the game and that the identification of the two games was trustworthy.

Now if *harpastum* was originally called *phaininda,* an interesting point, etymologically, is added to our hazy concept of the game, for the *Etymologicum Magnum,* of the tenth century, the oldest Greek lexicon, derives *pheninda* from *phennis,* which means *trickery,* which etymology, it will be seen later in this paper, has a direct bearing on as much as we know of the way the game was played. Athenaeus, however, tells us that the game may have been called *phaininda* because the players "shot"[2] the ball or because, according to Juba, the Mauretanian, the inventor was Phainestius, a trainer.

The reconstruction of the games of the ancients is an arduous task, usually with equivocal results. In the *Deipnosophists*[3] of Athenaeus, however, Antiphanes specifically describes the game of *phaininda* as follows:

> One player seized the ball, and rejoiced to give it to another, at the same time avoiding still another. He lifted another player to his feet, in the midst of shouts of "out-of-bounds."

He refers, also, to the violent twistings and turnings of the neck incurred in this game.

The grammarian, Julius Pollux, of the second century, A.D., who is the most authoritative writer on ball games of the ancients, gives us the following information about *phaininda*:

> It was so named either by a trainer of similar name or from the verb meaning *to deceive.* He explains the latter derivation by saying that the players pretend to throw the ball in one direction and then throw it in another.

Archaeological evidence to date has offered little help in the reconstruction of the game in question. In February, 1922, among

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[2] If this derivation is correct, *harpastum* is derived from *aphesis,* meaning *a sending away,* or *shooting* (as translated by Gulick in the *Loeb Classical Library* edition of Athenaeus)—a very doubtful etymological explanation.

[3] *The Deipnosophists,* or "The Sophists at Dinner" or "The Gastronomers" is the oldest cookery book extant. It might be called a philosophical treatise on dining: the "Sophists" engage in a heterogeneity of discussions.

the sculptured reliefs found in the Themistoclean circuit wall in Athens was one relief showing six players, three on each side, lined up at intervals behind one another, engaged in playing with a small ball.[4]

Those scholars who are certain that they have reproduced *harpastum* base much of their evidence on a treatise on *The Small Ball*,[5] written by Galen, a physician of the second century, A.D. This writer, however, is interested in different kinds of exercise through ball playing, and there is no conclusive evidence that he is describing only one game and that being *harpastum*. Galen does, however, offer us evidence that the ball was not kicked, for he refers to the exercise gained by the arms in throwing and by the legs in running. If the players had kicked the ball, Galen, in such a complete treatise on exercise by means of ball playing, would certainly have referred to the exercise gained by the legs in kicking.

The positive information we have concerning *harpastum* is thus seen to be scanty and may be summarized as follows: *Harpastum*, originally *phaininda*, was a game in which two or more players threw the ball to one another in such a way as to avoid a player between them.

Further information advanced concerning *harpastum* is largely conjectural. The fact that the ball could be caught either on a volley or on the first rebound is deduced from the adjective *pulverulenta* (dusty) and *arenaria* (sandy) applied, by transferred epithet, to the ball by Martial. Obviously, the ball might have landed on the ground, thus becoming dusty or sandy, without the implication that a point would be counted if the ball were caught on a rebound.

The players may have stood in a circle if we are to accept a passage from Isidorus—the circle of players standing by and waiting —yet this passage is corrupt, and can offer no positive evidence.

A passage from Sidonius Apollinaris may or may not be describing *harpastum*. It refers to a middle player (*medicurrens*) constantly losing his balance as he tried to return to his area of play, and of finally retiring breathlessly from the game. However, in the game so described, similar to our game, *Keep the Ball*, the players seemed to enter and to retire at will. Hence *harpastum* would not have been a team game.

Scholars have apparently confused the game of *harpastum*

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4 The *harpastum*, which was made of strips of leather and stuffed with hair, was the smallest ball of the ancients. Larger balls were filled with feathers or with air.

5 The writer has thought it worth while to include as an appendix to this article a translation of this treatise because she believes that it negates beyond doubt the assumption concerning the ancestry of football derived therefrom, *and* because she believes that there is an intrinsic interest in the pertinence of many of the items therein presented eighteen centuries ago!

with that of *episkyros*. While there is no evidence of kicking the ball in the latter game, there is some evidence, at least in the marking of the ground, that *episkyros* might have been a forerunner of soccer. Pollux explains the game thus:

Episkyros, a game of youths, was played with the member of one team matched with those of another. There was a middle line, the ***skyros***, upon which the ball was placed. There were two other lines, apparently goal lines. Those who had been chosen first sent the ball to the others whose task it was to throw the ball back. This performance continued until one team succeeded in throwing the ball beyond the goal line of the other team.

While this discussion presents but few facts concerning either *harpastum* or *episkyros*, the facts presented are those for which there is evidence, and many fanciful deductions have been ironed out. This game of *episkyros* is familar to the game of handball played in Germany, called in this country *German handball* or *field handball*.

Did the Greeks and the Romans play football? There seems to be no positive evidence to date that they did engage in pedal action with a ball. Perhaps the ancients, good runners as they were, were still not expert enought to meet a flying ball with their feet. Perhaps, too, many were like Epictetus who said that he could not catch a ball even if he spread out his coat to catch it in, let alone with his hands.

Appendix

(A translation of Galen's treatise *The Small Ball*)

Ancient authorities, both philosophers and physicians, have presented adequate treatises concerning the contribution of exercise to health, but they have failed to write concerning the superiority of exercise with the small ball over other forms of exercise. The purpose here, therefore, is to set forth some of these advantages gained from exercise with the small ball. Your criticism of this treatise, Epigenes, will be awaited, for you are expert in this form of exercise, and the hope is expressed that the treatise will be useful to any readers with whom you may share it.

That form of exercise is best which not only exercises the body but also is a source of joy to the participant. Men who engage in hunting with dogs are wise and understand human nature; they pleasantly modify their toil with a competitive element. The essential need of the soul for joyful outlet is corroborated by the fact that many men have avoided disease by the feeling of joy alone and, on the other hand, that many have become ill because of grief. No feeling of the body is strong enough to overcome the feeling of the soul, which must, therefore, be considered to be of prime importance. This advantage, then, is common to all exercises which provide an outlet for pleasurable expression, but there are some advantages peculiar to exercise with the small ball.

The accessibility of the exercise should be considered. When the amount of time that is needed for hunting is taken into account, it becomes obvious that busy men cannot engage in this form of exercise. When the equipment—nets, arms, horses, and hunting dogs—is considered, it becomes obvious that this form of exercise is prohibitive in the case of poor men. Exercise with the small ball requires little time and little equipment, and is, therefore, generally accessible. It does not cause any other activities to be neglected; indeed,

what could be more advantageous than an activity which partakes of every human fortune and action? It is readily seen that this form of exercise in its flexibility of adaptation to the needs of the individual is more effective than all other forms. It provides for strenuous or moderate movement; it provides for movement up or down; it provides for the movement of some parts of the body—loins, head, hands, thorax—more than of others; it provides for an equal movement of all parts of the body, requiring a maximum or a minimum of motion. No other exercise, except this with the small ball, exists which can be so well adapted to the current needs of the participant. A great expenditure of effort is required, for example, on the part of the players who strive to prevent the ball from being caught; indeed, many twistings of the neck are experienced, and use is made of many holds learned in wrestling. The loins and the legs, the foundation of the walking apparatus, are taxed by such activity.

The fact that this exercise, if the player plays in every position, is the only one which exercises all parts of the body should be stressed; also that there are equal periods of rest and of activity so that the player is not permitted to become sluggish, on the one hand, or unduly tired on the other. It also exercises the eyes, for the player must make adequate use of his peripheral vision to catch the ball. He must not throw the ball aimlessly; he must prevent another player from catching it; or he must catch the thrown ball. Being on the alert constantly may itself weaken the body; but when it is a product of exercise and of emulation, it tends toward joyful expression and contributes not only strength to the body but also wisdom to the mind, both of which qualities leaders wish to develop in their soldiers for the preservation of the laws. For the best leader must be both a guardian and a thief; he must attack the enemy opportunely, be in ambush when he is on the defensive, make an attack on a moment's notice, capture by strength or by strategy, and defend what has been taken. Is there any exercise, then, more suitable than exercise with the small ball for gaining or defending spoils, or for recovering stolen possessions, or for foreseeing the strategy of the enemy? Indeed this exercise even causes the sluggish and the dull to be revived. Many men who exercise only in wrestling develop muscles and bulk to the neglect of skill; to be sure, many have developed so much bulk that they can scarcely breathe, and, consequently, are not more fit than swine either for civil or for martial duties. Lest it be thought, however, that there is approval for any exercise which debilitates the body, it should be said that what is immoderate is condemned, and that anything which lacks measure is not beautiful. Races, therefore, that weaken the body and do not increase fortitude are not endorsed. Victory is not deserved by those soldiers who flee quickly but by those who have the fortitude to endure in close contest. The Lacedaemonians were powerful, not because they fled quickly, but because they persisted in killing the enemy. But if the question is asked to what extent running is beneficial to the body, the answer is that it is not beneficial insofar as it causes the parts of the body to be exercised unequally; in causing some parts to be exercised excessively and in leaving other parts inactive, it weakens the person and may even be the source of illness.

Therefore that form of exercise is recommended which contributes to the health of the body and to the harmonious functioning of the parts and to the strength of the soul—exercise like that derived from playing with the small ball, suitable for men needing development in strength or in speed. It is flexible in that it may be adapted both to the young and to the old, to the out-of-condition, or to the convalescent; the player who wishes to limit himself to moderate movement should take the middle position; after the exercise the

player should take advantage of a rubdown with oil and a bath—a relaxing procedure to revive strength.

Those who wish to profit most from this form of exercise must recognize which movements require more exertion, which less, and which movements affect the different parts of the body so that if they have become unduly tired in certain parts of their body because of their occupations they will know how to exercise with the small ball to bring the requisite amount of exercise to the various parts of the body. If a player standing in place throws a ball a great distance, he taxes the upper parts of his body more than the lower. But if a player runs quickly for a great distance, throwing a ball now and then, he will tire the lower parts of his body more than the upper; the speed of the exertion will tax the breathing. Throwing and catching without speed, however, increase the exertion and the consequent strengthening of the body. Throwing and catching with speed, the most violent of all exercises, tires the body and taxes the breathing. Although it is impossible to state the requisite quantity of exercise, it can be stated, however, that the intensity of the exercise is of no avail unless the dosage is sufficient, the determining of which is the task of the coach.

In conclusion, attention is called to the fact that in addition to the advantages of exercise with the small ball already named, this activity is not beset with danger. Races in which runners carry vases have resulted in broken vases and injured runners. The perils of horseback riding, jumping, and discus throwing are numerous. Participants in the gymnasium and on the athletic field are frequently injured. Just as Homer referred to those crippled, wrinkled, and with deformed eyes, so the participants in the gymnasium and on the athletic field become crippled, with distorted or broken bones. Thus to the advantages which have already been elaborated concerning exercise with the small ball, this supreme advantage—namely that it is not fraught with peril—is added.

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The Effects of Rapid Weight Loss Upon The Performance of Wrestlers And Boxers, and Upon The Physical Proficiency of College Students

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(Submitted for publication June, 1944)

THE PRACTICE OF RAPID WEIGHT REDUCTION

MANY college boxers and wrestlers, under the guidance of their coaches, rapidly reduce their weight directly before a match in order to compete in a lighter division. Purposely shedding a number of pounds of body weight and then engaging in very strenuous combat is not a normal procedure. It is done, obviously, to increase a competitor's chance of winning a match. Because such reduction in weight usually involves either one or all three of the following—interference with the laws of good nutrition, excessive exercise, artificial methods of dehydration—many interested persons question the effect of such rigorous procedures on the performance and health of the athlete. As usual, where little scientific data on a subject exists, tales begin to be spread. Some stories say that boys are kept in steam baths for a week before a contest and are literally "cooked down." Others tell of young men, who after spending most of their college careers "making weight," have died at an early age. On the other hand one hears it stated that withholding food from a combatant before a meet makes him angry, tough, and a better fighter. Where does the truth lie? Does weight reduction impair or improve performance and health? The writer was of the opinion that these questions deserved an answer and to this end he prepared a questionnaire which he sent to experts, namely coaches of college wrestling and boxing throughout the United States. Thirty-two replies were received from all sections of the country. A list of the institutions represented follows:

Army (U. S. Military Academy)	Cornell University
Brooklyn College	Haverford
University of California	University of Idaho
University of Chicago	University of Illinois
City College of New York	Kansas State College
Colorado State College	Muhlenberg

University of Michigan
Navy (U. S. Naval Academy)
University of Nebraska
North Carolina
Northwestern
Ohio State University
Oklahoma A. & M.
Polytechnic Institute of Brooklyn
Pennsylvania State College
Princeton University
Purdue
Rutgers University
Temple University
Tufts
Ursinus
Valparaiso (and Carleton College—one coach for both institutions)
Washington State College
Wisconsin (boxing)
Wisconsin (wrestling)
Wyoming University

Twenty-eight of the answers came from wrestling coaches. Four replies came from boxing coaches.

THE QUESTIONNAIRE

The following is the questionnaire which was used in the study. Use check marks to indicate your answer except where other information is asked.

1. Do you find that a sudden reduction in weight affects adversely the performance of a boxer or wrestler? Yes ..... No ..... (The reduction in weight referred to in question one and throughout the questionnaire is that reduction so commonly engaged in by boxers and wrestlers to fit into a specific weight classification.)

2. If your answer to question 1 is yes will you please indicate what you consider to be signs of poor performance?

3. Does sudden reduction in weight improve performance? Yes ..... No .....

4. If your answer to question 3 is yes, please indicate what you consider to be signs of better performance?

5. What percentage of sudden body weight loss would you consider as maximum if the performance of the boxer or wrestler is to remain unaffected? .....%.

6. What method of sudden loss of weight do you recommend as not affecting adversely the performance of a boxer or wrestler? (a) dehydration ..... (b) diet ..... (c) exercise ..... (d) combination of a, b, and c .....
(e) any other method (write in) .....

7. How many days before match time do you recommend that the sudden loss of weight start?

8. Do you believe that intermittent sudden weight loss during a wrestling or boxing career at college has any effect on the future health and longevity of the athlete? (a) decreases them .....(b) increases them .....(c) has no effect on them .....

9. Does a keen incentive to give a good account of one's self offset any evil effects of weight making as far as the performance goes? Yes ..... No .....

10. Do your above answers apply only to conditioned athletes? Yes ..... No .....

11. Would intermittent sudden loss of weight affect adversely the performance of everyday tasks by normal individuals? Yes..... No.....

12. If your answer to question 11 is yes would you say no if there were a keen incentive added to the work to be done? Yes ..... No .....

PURPOSE AND RELATIVE VALIDITY OF THE QUESTIONS

Queries one through four were designed to obtain the definite opinion of the coaches on the performance of an athlete after he had gone through a period of rapid loss of weight.

Fifteen coaches stated that it affected performance adversely, fifteen said it did not have a deleterious effect on participation, and two held no definite opinion. Among the signs of a performance below par were these: bad timing, slowness, quick fatigability, poor body balance, lack of endurance, mental sluggishness, body weakness, nervousness, illness, and frequent loss of contest.

Of the fifteen coaches who stated that performance was not any worse among those who lost weight rapidly, eight said it improved performance. The evidences of improved action were listed as greater speed due to loss of excess weight, better endurance, more stamina, better timing, increased enthusiasm, improved muscular control, and a larger percentage of victories.

It is noteworthy that the same elements of good performance are listed by one group as having been improved and by the other as having been depreciated. These coaches are experts. Their opinions carry a large amount of validity. They appear to agree on what the elements of excellence ought to be. But they seem to disagree on what effects quick reduction in weight has on these fundamentals. At first glance this would seem to be a clash of opinion. However the next paragraphs will show that the conflict was more apparent than real.

DESCRIPTION OF RAPID WEIGHT REDUCTION

Question five asked what percentage of rapid weight reduction was maximum if performance was not to be affected adversely. Of the two coaches who did not answer questions one through four, one said 7 per cent, the other said five pounds.

Those who claimed rapid weight reduction affected performance adversely said that the following percentages of loss in poundage *would not* adversely affect performance in the frequencies indicated in parentheses: 10 per cent (2), 5 per cent (4), 3 per cent (2), 2 per cent (1), variable (3). A few expressed their opinion in pounds. Based on the weight of the median wrestling group, i.e., 155 pounds, these may be expressed as follows, 4 pounds or approximately 3 per cent (1), 3 pounds or approximately 2 per cent (1), and 2 pounds or approximately 1 per cent (1).

Those who said there was no disadvantage arising from rapid reduction listed the following percentages as being safe amounts of

loss: 8 per cent (1), 7 per cent (3), 6 per cent (2), 5 per cent (2), 4 per cent (1), 3 per cent (1), 2 per cent (1), variable (1), no statement (1). Two expressed their answers in pounds: 8 pounds or approximately 6 per cent (1), 6 pounds or approximately 4 per cent (1).

It is to be remarked upon that even those coaches, who stated flatly that quick weight reduction caused a deterioration in quality of performance, believed that a certain amount of weight could be lost rapidly without any ill effect. Some even believed that up to 10 per cent of the body weight could be thus lost. This was a higher range in reduction of weight than that stated by those who held an opposite view. Because there were men among both groups who stated that the amount of safe reduction was variable, an average could not be fairly taken here. However, if a mean were actually attained for both groups here by disregarding indefinite statements, that of the coaches who favored rapid weight reduction would be somewhat higher than the average of the opposite group (5.4 per cent as opposed to 4.5 per cent). In view of the overlapping of ranges, this difference in means is not great enough to indicate a real conflict. That the two sets of coaches when asked directly about this, gave different opinions, though intrinsically they believed similarly, merely means that some of them, while opposed to drastic reduction, are not certain of where rapid loss of weight stops being safe and becomes harmful. Actually the range of opinion stated in answer to question five tends to corroborate Tuttle's experiment[1] in which he discovered that a wrestler may lose up to five per cent of his body weight directly before match time without suffering any deleterious effects. An experiment which took into consideration losses up to ten per cent might show the same result and bear out even more directly the opinions of the coaches. This is a project that might well be carried out and thus aid in limiting rumors about the advantages and disadvantages of weight making as regards performance in contests.

The amount of weight loss is only the beginning of a description of rapid weight reduction. There must be included the procedures used and the time taken as well. The answers to question six showed that eighteen of the coaches believed in using a combination of dehydration, exercise, and diet to effect the rapid loss. Ten believed in combinations of two of the three methods, two did not answer, one depended upon dehydration alone, and one used only exercise to effect reduction.

The answers to question seven showed that the period of days

1 W. W. Tuttle, "The effect of Weight Loss by Dehydration and the Withholding of Food on the Physiologic Responses of Wrestlers," *Research Quarterly* (May, 1943), pp. 158-166.

for rapid weight loss according to frequency was as follows: 1 day (4), 2 (7), 3 (2), 4 (2), 5 (3), 7 (8), 8 (1), 10 (1), 21 (1), 28 (1), 30 to 60 days (1), and variable (1). Twenty-six of these thirty-two experts believed a week or less was sufficient time in which to reduce weight rapidly.

In these three statements of amount of loss, methods of reduction, and period of days used to affect the decrease lies a description of what thirty-two experts consider rapid weight loss.

INCENTIVE, HEALTH, AND APPLICABILITY OF THE ANSWERS

1. Question nine dealt with incentive, which is an integral part of the morale of any team. Fifteen of the coaches believed that such mental stimulus could offset whatever evil effects rapid loss of weight might have on the body. Fourteen believed it could have no such compensatory effect, while three expressed no opinion on this point. Those who thought incentive an aid were about evenly drawn from those who believed rapid loss had an adverse effect upon performance and those who did not.

2. Twenty-six of the thirty-two coaches said their answers applied only to conditioned athletes.

3. Twenty-three of the thirty-two coaches stated that intermittently losing weight quickly during a college career had no effect on the longevity or health of an athlete, four said it decreased them, three said it increased them, while two did not answer. None of these statements showed evidence on the blank side of the sheet where each respondent was asked to make any supporting statement on the answers he gave. It is doubtful whether any of the coaches knew his students long or well enough to give a valid answer to the question.

4. Finally, questions eleven and twelve were designed to discover the opinion of these men as regards civilians who might have to work extended hours on short rations which might cause rapid loss of weight. Twenty coaches believed that normal individuals would not carry on as well as normally in such a situation. Ten said the opposite. Two did not answer. Of the twenty who answered that performance would be impaired seven said incentive would make no difference, thirteen said it would. Again, there was no supporting evidence and the answers of these men cannot be considered valid. On the question of incentive, the heroic labor of the people in Russia, England, and China at times when food was short might be contradictory to the reply given by the coaches on this point.

The last two questions were included because of the actual situation which exists all over the world where people are produc-

ing and fighting successfully even though food is scarce. It was believed that some evidence to explain these situations might be adduced. With this in mind the author, though no information was obtained from the coaches, carried on a brief experiment in an attempt to shed some light on the question. It is described below.

INVESTIGATION INTO EFFECT OF RAPID WEIGHT LOSS ON MOTOR PROFICIENCY TESTS

During the twelfth week of the 1944 spring term at Brooklyn College a large number of students were invited to take part in a short investigation to determine the effect a brief period of dehydration and reduction in food intake has upon the body weight and upon certain motor capacity tests. Fifty of these students were chosen as the experimental group (X) while sixty were picked to be the control set (C). All of these students were freshmen and sophomores who had been given practice in all of the tests involved in the experiment for the first twelve weeks of the term, and who were medically approved for physical training. Each of these young men was given the following test in the early part of the twelfth week: pull-ups, dips, standing broad jump, and the Burpee exercise repeated continuously for one minute. The height, weight, and age of each man was secured before the first test as well as before the second one which was given two and one-half days later.

During the two and one-half days intervening between the first and second test, the X group ate the food listed below for two days and took only breakfast on the third day before submitting to the second set of physical tests. Besides this the men took only two glasses of water on each of the first two days of the period of reduced intake and one glass on the morning of the day of the second test. The C group ate and drank normally for two and one-half days after the first test and then submitted itself for the second examination.

Before discussing these results the question as to whether the two groups were alike must be answered. They were directly comparable on the day of the first test as follows:

1. Their average ages were the same.

2. There was no significant difference in their average heights.

3. The standard[2] weight for men of 70 inches at the age of 18 is 151 pounds. It is hygienically advantageous for men at this age level to be somewhat above the average. The average weights of both groups fulfilled this requirement.

4. Both groups had practiced the proficiency tests for the eleven

[2] T. Kirkpatrick, and A. Huettner, *Fundamentals of Health* (Boston, Mass.: Ginn & Co., 1941), Table XVIII, p. 187.

TABLE I

REDUCING DIET OF FRESHMEN AND SOPHOMORES

	Item	*Caloric Value*[3]
Breakfast	Grapefruit Juice (4 oz.)	37
	1 Egg	75
	1 Slice of Bread	80
	Coffee (2 spoons of sugar and milk)	50
Lunch	1 Glass of Milk	170
	1 Slice of Bread	80
	1 Slice of Meat or Fish	195
Supper	Meat or Fish (2-3 oz.)	250-400
	Potato (small)	80
	Lettuce	20
	Sweetened Coffee or Tea	50
	Slice of Cake or Small Pudding	100
	Total Calories	1187--1337

The results of the two tests are shown in Table II.

TABLE II

RESULTS OF TESTS SCORES OF X AND C STUDENTS—AVERAGE SCORES

	Chins	*Dips*	*Jump**	*Burpee*	*Weight*	*Height*	*Age*
			Group X				
Test 1	5.9	18.2	75.4	25.9	159.6	69.6	17.9
Test 2	5.6	17.4	75.2	25.6	157.2		
D/σD	.6	2.1	1.9	.38	8.0		
			Group C				
Test 1	6.3	18.	78.7	22.3	156.3	69.9	17.9
Test 2	6.5	18.	79.2	22.1	157.3		
D/σD	.28	0.	.18	.27	.41		

* Standing Broad Jump is in inches.

weeks previous to the investigation under the same conditions in their physical training classes. All effects of practice were already taken account of in the daily work of the course. The men were all at their peak for these tests.

5. Both groups were medically approved for normal college physical education.

On the day of the second test it is to be noted that the X group was 2.4 pounds lighter than it was just before the first examination while the C group was one pound heavier. The D/σD for the loss in weight is 8. It is statistically significant. No other variation on the tests as revealed by Table II showed any significant difference.

3 H. Diehl, *Textbook for Healthful Living*, Appendix B (New York: McGraw-Hill Book Co., 1939).

It appears therefore that the performance of each group neither improved nor retrogressed on the second test as compared with the first though there was a significant change in the weight of the X group but not in the C group.

While the above experiment was too brief for any broad claims to be made from it, it is the author's opinion that this investigation, Tuttle's experiment, and the results of the questionnaire make a strong argument in favor of believing that a certain percentage of body weight may be rapidly lost without affecting some performances in physical activities.

A Philosophical Interpretation of a Program of Physical Education in A State Teachers College

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(Submitted for publication July, 1944)

I. THE PROBLEM OF THIS STUDY

A PHILOSOPHICAL interpretation of an actual program of physical education is undertaken in this study. For the philosophical interpretation the philosophies of realism, pragmatism, and idealism are used, and the program of physical education, that of the State Teachers College at Worcester, Massachusetts.

The study is undertaken because of the interest, as shown by their writings, of members of the physical education profession in philosophy as applied to that field. It is also undertaken because of the service of philosophy to education, and because of the author's interest in philosophy and in physical education. Those members of the profession who call upon philosophy seek its service in the analysis of objectives and the understanding of basic principles, in the building of morale within the profession, in defining trends in physical education, and in making the best approach to the pupil. Usually when members of the physical education profession have used the term "philosophy" they have actually meant "principles" or "maxims," or they have re-introduced old professional controversies such as that between professional versus general education.

The writer has long agreed with other physical educators in believing that philosophy can serve physical education. This belief rests on her appreciation of the service of philosophy to education in general as well as its service in her teaching of physical education for several years. This detailed study is made because of the recognition of the need for a sound philosophy in physical education.

II. THE METHOD USED

The method used in this study is the interpretation of the detailed parts of a program of physical education in terms of the three philosophies of realism, pragmatism, and idealism. Certain specific

This is an abstract of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the School of Education of New York University, 1943. The author is now Mrs. Joseph K. Gannett.

proponents of each philosophy are consulted. The authors thus consulted are: *for realism:* Ralph Barton Perry, Frederick S. Breed, Roy Wood Sellars, and Bertrand Russell; *for pragmatism:* Charles S. Peirce, William James, John Dewey, William Heard Kilpatrick, and Boyd H. Bode; *for idealism:* Friedrich Froebel, William E. Hocking, Rupert C. Lodge, Robert R. Rusk, Bishop Francis John McConnell, and Herman Harrell Horne. Certain of the works of these authors are listed below, in VI, describing the source materials.

The basic tenets of each philosophy are described according to the proponents consulted. The basic tenets are formulated around the ten main philosophical topics; *viz.*, the nature of the world, mind and body, self, values, knowledge, truth, beauty, will and free will, the good and evil, and the existence of God and religion.

The summaries of the views of the proponents of the philosophies are given for realism, pragmatism, and idealism as follows:

Realism maintains that nature sets the boundaries of man's world in which intelligence is a function of the body as the physical organism and the environment interact. Society preserves and transmits the methods and facts gained by man's intelligence. Knowledge makes no difference to what is known, and reality is independent of any knower. The distinction between the new realism and critical realism is shown. The new realist believes that the object is known as it is, while the critical realist holds that consciousness interprets reality for man, and that this prevents him from having genuine knowledge of the world.

The leading pragmatists assert that man attains usable, mutable truths as he acts purposefully in an environment of perpetual change. For Peirce, pragmatism is a method for clarifying ideas, for James, a search for truth which is found in workable ideas, and for Dewey it is the technique of instrumentality which permits man, nature bound, to integrate himself with the ongoing processes of nature and of man.

According to the philosophy of idealism, the universe is of the nature of the mind, an expression of absolute mind. Mind explains physical nature and gives genuine knowledge of spiritual realities. Standards for truth, beauty, goodness are eternal, but man's efforts to attain them change. Man is innately capable of good and his efforts to approach the infinite meet success in a benevolent universe.

The program of physical education used in this study is the work of the author who is director of physical education at the State Teachers College at Worcester, Massachusetts. The program was formulated in 1940-1941, taught in revised form in 1941-1942, and in improved form in 1942-1943. The main divisions of the program interpreted are the health guidance program, the course in Hygiene

for Freshmen, the courses for all students in physical education, and the professionalized courses in the teaching of health, safety, and physical education, as well as the program of the Women's Athletic Association.

The method used in this study interprets the various parts of the program according to the descriptions of the three philosophies. The three philosophies are used to interpret the parts, comparisons being made to show primary, secondary, and tertiary stress. The interpretation is objectively made as the summaries of the philosophies are used to analyze the stress of the present teacher of the program, and other possible emphases.

III. EVIDENCES LEADING TO FINDINGS

Evidences of the influence of the philosophy of realism are noted in the use of requirements, grades, texts, tests, learning of sportsmanship and social conduct, and the development of the maximum of physical vigor and health.

The pragmatic emphases noted are those that provide for changes in plan and program, for student choice of program and activity, for direct experience to give sociological background and skill development, for group cooperation and planning, for the adjustment of the individual to nature (principally one's own physical organism), and to society, for opportunities for meeting problems, and the development of skills for problem solving and social interaction, for the continuous development of standards to guide conduct, and for the measurement of status and progress in health and physical education.

The idealistic stresses noted are that students, under guidance, choose objectives, activities, textbooks, topics for reports, and the like; that data about students, both objectively and subjectively derived, are used for individual guidance and group planning; that the program provides for building wholeness of mind and body; that the lives and works of great leaders are used to enrich the lives and works of a younger generation; that there are many ways of accomplishing the ends of education; and that it recognizes the supreme worth of personality in student, administrator, and teacher, both of the teacher of any subject as well as of physical education, and of the teacher of this program. The program is also idealistic in helping to bring about the values of life that conserve and enhance personality. Among these are the development of strong, healthy bodies; good habits of mental and physical health; skill, success, and fun in physical activity; and the right start in the teaching of health, safety, and physical education to children.

Principally it is the philosophy of idealism with a secondary stress on realism, and a tertiary stress on pragmatism that is at

work in carrying out the program described. Although certain realistic and pragmatic features are utilized, they serve the ends of idealism so that the final summary of the program shows it to be chiefly idealistic.

IV. FINDINGS OF THE STUDY

It is concluded from this study that physical education can be interpreted philosophically, that it contains factors which can be so treated. The study increases the understanding of the significance of the program itself, shows ways of improving the handling of the program and of obtaining a better balance between the parts of the program. It shows the possibilities of using philosophy to define and to delimit the field of physical education and it throws light on the possible future role of various phases of the entire physical education program.

This study has assisted the teacher, the present author, professionally to find her real role, to see her strengths and to build thereon, to see some of her weaknesses and to search for others.

V. IMPLICATIONS OF THE STUDY

The conclusions of this study that deal with possible future implications are:

1. Physical education can be interpreted philosophically by a further use of the three philosophies of this study, realism, pragmatism, and idealism, as well as by other philosophies such as naturalism and new realism. This study represents the first work in the comparative use of philosophy applied to physical education.

2. Programs as a whole can be interpreted philosophically.

3. Varied phases of physical education programs can be interpreted philosophically.

4. Physical education teachers can increase their understanding of their own programs, methods, pupils, administrators, and colleagues through a philosophical approach to their work.

5. Philosophy is needed by physical education as a profession for clarifying, understanding, broadening, unifying, integrating physical education as a whole and as itself a part of education.

6. Physical education should be intepreted philosophically.

VI. SOURCE MATERIALS

The full list of source materials appears in the body of this thesis. Among the sources mainly used are the following:

For realism: Ralph Barton Perry, *Present Philosophical Tendencies;* Frederick S. Breed, *Education and the New Realism;* Roy Wood Sellars, *Critical Realism;* Bertrand Russell, *Philosophy, What I believe.*

For pragmatism: John Dewey, *Democracy and Education, Education Today;* Joseph Ratner, *The Philosophy of John Dewey;* William Heard Kilpatrick, Editor, *The Educational Frontier;* Boyd H. Bode, *Fundamentals of Education.*

For idealism: Friedrich Froebel, *Education of Man;* William E. Hocking, *Human Nature and Its Remaking, Types of Philosophy;* Rupert C. Lodge, *Philosophy of Education;* Bishop Francis John McConnell, *Religious Certainty, Human Needs and World Christianity, Christian Materialism;* Herman Harrell Horne, *The Philosophy of Education, Idealism in Education,. Free Will and Human Responsibility.*

Besides the source materials concerning the philosophies of realism, pragmatism, and idealism used in this study there is the program of physical education of the State Teachers College at Worcester, Massachusetts. As previously stated, it was prepared by the author of this study for use in the program at the college, and in that form, not presented as ideal, was used as the basis for the philosophical interpretation reported here.

The Development of Fundamental Sport Skills In College Women of Low Motor Ability

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(Submitted for publication June, 1944)

A COURSE in sport skills has been offered for several years at the State University of Iowa to meet the special needs and interests of freshman women who receive low scores on the standardized motor ability test (the Scott test [8 9*]) which is given to medically approved women shortly after entering the University. These students have not become proficient in simple running, jumping, and throwing, and cannot make much speed in a short obstacle race requiring agility and quick changes of direction. The project reported here supplies information which may be used as a basis for making the sport skills course more effective and more useful to such students. The writer was concerned chiefly with the selection and evaluation of subject matter and the preparation of teaching materials for three successive sets of experimental and control classes, each of which received fourteen or fifteen half-hour lessons. Preliminary studies were made relative to the experience, needs, interests, and characteristics of low motor ability students, the fundamental elements in the sports most popular with college women of low motor ability, and current ideas regarding learning and methods of teaching. [2, 6, 10]

The experimental programs for teaching sport skills were proposed by the writer on the basis of her experience and the preliminary studies; the control programs were similar to those previously used at the State University of Iowa. In each set of lesson plans, provision was made for giving the Scott motor ability test both at the beginning and at the end of the course in order to establish the status of the individual and to provide an objective measure of improvement.

SUBJECTS

The preliminary questionnaire on the physical education program in elementary school and in high school was answered by nearly

This is an abstract of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, State University of Iowa, 1944.

* Superior figures refer to numbered bibliography at end of article.

all women entering the University in September, 1941. Another questionnaire on student attitudes and interests was answered by freshman women taking final examinations in physical education activity classes at the end of the first semester of the 1941-42 college year. Students receiving *T*-scores of 58 or above in the September motor ability test constituted the high motor ability group, those receiving *T*-scores of 42 or below, the low group in these questionnaire studies.

The plans for teaching sport skills were carried out in eight regularly scheduled physical education activity classes for freshmen. Four of these classes were scheduled for the first eight-week period of the second semester in the 1941-42 college year. The following year two classes were conducted during the first half of the second semester and two during the last half.

Of the 254 students enrolled in these eight classes, 102 (40 per cent) received *T*-scores of 42 or below in the September motor ability test. But when the test was repeated at the beginning of the sport skills class, only 41 (16 per cent) received scores of 42 or below. The comparison of results obtained with the experimental and control programs was based on the records of the 130 students who received *T*-scores of 50 or below at the beginning of the sport skills classes. Of this low motor ability group, 70 were in the experimental classes and 60 in the control classes.

RESULTS

Physical Education Background

Opportunities for instruction and practice in physical education activities in elementary school and in high school were found to be much greater for the high motor ability group than for the low group. Supervised physical education in elementary school was reported by 30 per cent of the high group, by 24 per cent of the low group. In high school 94 per cent of the high group engaged in a regular physical education program as compared with 77 per cent of the low group. The program included seven or more activities for 51 per cent of the high group; only 26 per cent of the low group had such a varied program.

Student Interests and Needs

The sports most popular with the low motor ability group were swimming (and diving), tennis, golf, archery, horseback riding, badminton, hiking, basketball, table tennis, and skating. The sports mentioned most frequently as being least interesting were basketball, volleyball, softball, and hockey. From a list of probable reasons, lack of skill was checked most frequently as the reason for not liking the least interesting sports. The chief reasons for below average

skill were a lack of interest, poor instruction in elementary school (but not so much in high school), and a lack of time for participating in extracurricular sports. Below average natural ability was also recognized as a factor.

From the literature and from the questionnaires it appears that college women, especially those of low motor ability, tend to choose moderate rather than strenuous sports. Many college women are not interested in attaining high degrees of skill or in a highly competitive sport program.

Physiometric Factors

The records of students in the four 1942 sport skills classes were used to show whether there were any significant differences between high and low motor ability groups with respect to a number of measurable characteristics. The groups above and below the *T*-score level of 50 at the beginning of the course in sport skills were about alike with respect to height, weight, weight deviation from the normal, body build, and flexibility. The high group was definitely superior, however, with respect to serial reaction time, strength, and strength-weight indices. Less than 30 per cent of the low group received better strength scores than the average for the high group. In the serial reaction time test 15 per cent of the low group received scores better than the average for the high group. Only 13 per cent of the low group had higher strength-weight indices than the average for the high group.

Observed Differences Between Skilled and Unskilled Performers

Systematic observations were made from time to time by the writer and members of the experimental classes. It was noted that the movements of the poorer performers were not well adapted to their purpose; they tended to be poorly coordinated, lacking in force, and not well timed. Many individuals had not learned how to mobilize and apply the strength they undoubtedly possessed; there was an evident lack of skill in judging speed and distance. Skilled players were expert in anticipating their next move, and they were ready for it, whereas unskilled players were often caught off balance or out of position.

Analysis of Popular Sports

The ten sports ranking highest in popularity with low motor ability students were analyzed for this study by a group of four experienced teachers of physical education. This analysis was made in terms of fundamental bodily movements, mechanical requirements as described by Glassow,[4] skill elements as listed by Cozens,[7] and physiometric elements. Under each of these classifications, ratings were given to the following items in the order listed, beginning with the highest and omitting those of little or no importance.

Fundamental bodily movements: running, jumping, striking.

Mechanical requirements: maintaining equilibrium, moving the body from place to place, moving objects by the strength of the body.

Skill elements: balance, general bodily strength and freedom of movement, arm- and shoulder-girdle strength, hand-eye coordination with and without leg speed, ability to change direction quickly, arm- and shoulder-girdle coordination with implements.

Physiometric elements: coordination (skill), reaction time (alertness), endurance, strength, speed of movement.

Among the sports thus analyzed, basketball, tennis, and badminton received higher ratings than the others as to the importance and variety of fundamental bodily movements and skill elements; they also received higher ratings with respect to mechanical and physiometric requirements. Since these sports offer more opportunities than the other popular sports of learning valuable skills, and since they tend to call forth greater effort on the part of the participants, they were considered to be of greater value than the others for use in the sport skills program.

Educational Procedures

The following procedures were selected as guides in making the teaching of sport skills effective:

1. Establishing worthy and well-defined goals.
2. Providing good demonstrations.
3. Supplying pertinent facts so that the student will be likely to adopt worthy goals and wise plans of action.
4. Promoting the growth of insight and understanding.
5. Analyzing problem situations carefully.
6. Fostering the progressive reorganization of ideas and response patterns.
7. Giving the student information about her own progress.
8. Spacing practice time to good advantage.
9. Practicing functional units as a whole before working on details.
10. Providing an atmosphere which is conducive to learning.

The Experimental Program

About half the time in the experimental program was devoted to the playing of basketball, volleyball, aerial darts, and table tennis. Basketball and table tennis ranked only eighth and ninth, respectively, in popularity with the low motor ability group, but as has already been pointed out, basketball ranked high in many elements needed for proficiency in a variety of sports. Volleyball, aerial darts, and

table tennis were included to supply opportunities for acquiring skill in striking. From the point of view of the available space and equipment, these sports were considered to be more suitable for use in conjunction with the teaching of fundamental sport skills than the more popular tennis, golf, and badminton. Both basketball and volleyball were included in spite of the fact that they headed the list of sports in which low motor ability students were least interested. A large part of the prejudice against these sports seemed to be overcome as the students became more skillful in playing them.

The special features of the experimental program were as follows:

1. The playing of selected games to call attention to the need for developing fundamental skills and to furnish opportunities for using and further perfecting the skills chosen for special study.

2. The presentation and discussion of some of the findings from the preliminary studies and the results of the performance tests given in the sport skills classes.

3. A study of procedures for gaining skill, strength, and endurance.

4. The study of selected skills, emphasizing the importance of careful observation and analysis, well directed practice, and an understanding of the principles involved.

5. The use of objective tests and visual aids.

In regard to the development of skill it seemed to the writer that the greatest amount of improvement was achieved as individuals learned to analyze the situation and adapted or developed their capacities to meet a specific set of requirements. The individual must learn how to coordinate her movements effectively, avoiding muscular tensions that would interfere with a smooth sequence of joint movements; she must learn to judge speed and distance, and put forth the right amount of effort in performing various skilled acts. The importance of footwork and positions of readiness was emphasized, and the common elements in various forms of throwing and striking were noted.

The skills selected for detailed analysis and instruction were as follows:

1. Short straightaway dash from a standing start.
2. Running with quick changes of direction.
3. Jumping for distance.
4. Jump and reach for height.
5. Throwing and catching for speed.
6. Throwing for accuracy.
7. Throwing for distance.

Maximum effort was called for whenever possible in order to extend the range in which the skilled act could be performed. Throwing or jumping for distance, throwing for speed, and running for speed or endurance provide situations in which the individual has an urgent reason for putting forth her best effort. The physiologic reaction is an increase in the capacity for making such efforts.

Specific skills in striking were not selected for intensive study for several reasons. In the first place, the writer thought that it would be relatively easy to teach striking to a student who already knew how to throw well. She also thought that the similar sequences of movement in throwing and striking could be learned more easily without implements. Even if the necessary provisions could be made for equipment and safety, the use of basketballs and softballs seemed preferable to teaching the power strokes of such sports as golf or tennis to a large class in a gymnasium. Objective evidence to support these ideas was not obtained in the present study.

The 1943 experimental programs made greater provision for the teaching and practice of speed running, broad jumping, and basketball distance throwing than did the 1942 program. Progress was also made in preparing students more adequately to help each other, in demonstrating new material, and in analyzing the difficulties encountered by unskilled performers.

The performance tests which were used to define specific goals and measure progress were as follows:

1. The five items of the Scott motor ability test.[8, 9]
2. Side-stepping shuttle race with lines 8 feet apart.[7]
3. Basketball partner passing for speed at 8- and 16-foot distances.
4. Jump and reach for height.
5. Thirty-second basketball goal test.
6. Overarm softball throw at a wall target.[5]
7. Underarm softball pitch at a target.[5]
8. Softball bowling at a baseboard target.
9. Push-pull strength test.[7]
10. Forward reach flexibility test.

The 1942 experimental classes helped to make a film on the teaching of sport skills. The 1943 classes had an opportunity to see this film on two occasions and to correlate what they saw with the work they were doing in class. Basketball backboard spots[1] and center goal markers were used as visual aids in achieving accuracy in goal shooting by both of the 1943 experimental groups.

The Control Program

All of the time, except that needed for the preliminary and final tests, was spent in the coaching and playing of basketball,

volleyball, aerial darts, and table tennis. In the control program the emphasis was on learning and playing the game rather than on the development of fundamental skills and the techniques for gaining skill.

The lesson plans for the three experimental and control programs, the analysis of special skills, the specifications for the tests given, and the script of the teaching film are included in the appendix of the dissertation.

Improvement Made by the Experimental and Control Classes

On three successive occasions the experimental classes made significantly greater improvement in the Scott motor ability test than the control groups did. The average improvement for the three sets of classes, the number of cases in each group, the difference in improvement between the averages for the experimental and control groups, and the *t*-ratio for evaluating these differences are given in Table I. Similar information for the five items of the Scott test is given in Table II.

According to Table I the average improvement of the experimental groups ranged from 5.5 *T*-score units in 1942 to 9.5 units in March, 1943, whereas the greatest average improvement in the controls was only 2.9 units.

From Table II it can be seen that the basketball distance throw was the item showing the greatest and most consistent improvement. Average gains of 6.2 and 7.4 feet respectively, were obtained by the 1943 experimental groups. The superior gains made by the March, 1943, group in running and the wall pass, and those made by the January, 1943, class in the obstacle race indicate what can be done when slightly greater emphasis is put on these items in the teaching and practice program.

Substantial increases in strength were obtained when arm-strengthening exercises were emphasized and included regularly in the experimental program, but the difference in improvement between the experimental groups and the controls who did not practice special arm-strengthening exercises was not significant. The strength-weight index was significantly correlated with motor ability test scores and probably also with improvement. Evidence in support of the latter was not conclusive because data on improvement were available for only the low ability group, not for the whole class.

The use of visual aids in basketball goal shooting resulted in significantly better scores for the March, 1943, experimental class as compared with the controls.

From the analysis of answers in the written examinations given at the end of the 1943 courses in sport skills it appears that the ex-

TABLE I

GAIN IN MOTOR ABILITY TEST SCORES FOR THE THREE SETS OF EXPERIMENTAL AND CONTROL GROUPS RECEIVING *T*-SCORES OF 50 OR BELOW AT THE BEGINNING OF THE COURSE IN SPORT SKILLS

	Average Improvement (Number of Cases)			
Date	*Experimental*	*Control*	*Difference*	*t-ratio*
February, 1942	5.5 (30)	2.1 (31)	3.4*	2.9*
January, 1943	7.6 (19)	2.9 (16)	4.7*	3.3*
March, 1943	9.5 (21)	1.4 (13)	8.1*	6.2*

* Significant at the 1% level of confidence.

TABLE II

GAIN IN MOTOR ABILITY TEST ITEMS FOR THE THREE SETS OF EXPERIMENTAL AND CONTROL GROUPS RECEIVING *T*-SCORES OF 50 OR BELOW AT THE BEGINNING OF THE COURSE IN SPORT SKILLS

		Average Improvement			
Test Item	*Date*	*Experimental*	*Control*	*Difference*	*t-ratio*
Basketball	Feb. 1942	3.7	0.6	3.1**	2.3**
Throw	Jan. 1943	6.2	0.2	6.0*	3.8*
(feet)	Mar. 1943	7.4	—0.8	8.2*	4.6*
4-sec. Dash	Feb. 1942	0.8	0.1	0.7#	1.5#
(yards)	Jan. 1943	0.9	0.7	0.2#	....
	Mar. 1943	1.7	0.5	1.2*	2.7*
Basketball	Feb. 1942	0.0	0.3	—0.3#	....
Pass (times	Jan. 1943	0.6	0.9	—0.3#	....
in 15 sec.)	Mar. 1943	2.0	0.8	1.2*	2.7*
Broad Jump	Feb. 1942	4.7	2.5	2.2#	1.7#
(inches)	Jan. 1943	4.7	3.4	1.3#	1.0#
	Mar. 1943	5.9	2.3	3.6***	2.0***
Obstacle	Feb. 1942	1.5	1.3	0.2#	....
Race	Jan. 1943	2.0	0.9	1.1**	2.4**
(seconds)	Mar. 1943	1.1	0.7	0.4#	....

* Significant at the 1% level of confidence.
** Significant at the 2% level of confidence.
*** Significant at the 5% level of confidence.
\# Not significant.

perimental groups have a better understanding than the control groups do of the principles governing successful performance in certain fundamental skills. The reaction to the practice of special skills was, for the most part, very favorable. The most frequent request from the March experimental class was for more individual help and the chance to apply skills and play games. Many students, however, liked the program as it was. Several students suggested that there should be more time for practice on fewer games and skills, and that the subject matter should be explained more thoroughly; evidently a course of fourteen or fifteen lessons was too short.

GENERAL DISCUSSION AND EVALUATION

This project is representative of the work that should go into the revision of any course of study. Although the findings are most applicable to the situation at the State University of Iowa, they may also be of considerable interest to those who are working along similar lines, or to those who wish to establish courses in sport skills for students of low motor ability.

Not only did the experimental groups surpass the controls in objectively measured improvement, but they also seemed to be better equipped from the standpoint of interests and attitudes to continue with physical education courses and with recreational sports. It has been demonstrated that almost everyone in a low motor ability group can make appreciable improvement in various skill tests by devoting only a small amount of time to direct practice. Students who think they are handicapped because of their height, weight, or body build can be reassured that these factors are of little importance in determining proficiency since individuals of various sizes and proportions are found in both the high and the low groups.

The hope and the actuality of success in athletic performance are new experiences to some of the low motor ability students. By fostering favorable attitudes and promoting new interests in sports as well as by developing essential skills, the proposed course in sport skills seems to have accomplished in an effective manner the special purposes for which it was designed.

Too often students and even instructors are satisfied with unnecessarily low levels of performance. Furthermore there is a marked tendency among those of low motor ability to avoid sports that require and develop strength, speed, and endurance. The situation can be remedied, at least to some extent, by providing a special class in which the poorer players can get suitable group and individual instruction, and in which they do not have to compete against a large number of superior players. The presence of a few expert players in the sport skills class is a decided advantage, however, because these students help to set a good example and show what can be done, thus helping to establish high standards of performance and define worthy goals. Good demonstrations not only help the student to define her goal, but they also give clues as to how the goal may be reached. The teaching film on sport skills, which furnished many illustrations of good and poor performance, undoubtedly helped to train the students in the critical observation of bodily movements, and gave emphasis to many of the points brought out through other parts of the instructional program.

CONCLUSIONS

In the light of the observations and experimental findings described above, the following conclusions seem to be justified:

1. A sport skills program in which about half the time is devoted to the study of selected skills and the essential differences between good and poor performers, and the other half to the playing of such games as basketball, volleyball, and aerial darts, is effective and practicable for college women of low motor ability.

2. Instruction and practice should be given in the fundamentals of running, jumping, throwing, and striking. Special emphasis should be placed on the forms of these activities that induce the individual to put forth great effort so that physical capacity as well as skill will be developed.

3. Although there is considerable improvement in running, jumping, throwing, and striking as a result of participation in an activity program centered around the coaching of one or more sports, significantly better results can be obtained by working directly on the analysis and practice of selected forms of these fundamental bodily movements.

4. The use of a teaching film appears to be a valuable supplement to other forms of instruction.

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The Measurement of Certain Aspects Of The Physical Fitness of College Women

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INTRODUCTION

PHYSICAL education is expected to play a part in making women physically fit for the increased demands of wartime—shouldering men's jobs in agriculture, industry, and professions, maintaining homes and bearing children, besides performing community service. It is recognized that physical education activities represent only one factor in the total environment of the college student, and whatever contributions they make to the physical fitness of an individual may be augmented or diminished by a variety of other factors. As one attempt toward evaluation of physical education activities, measurement can be made of their effects as they exist in the total background of college life.

The many definitions of physical fitness may be simplified to the following statement: physical fitness is the ability to make an adequate physical and emotional adjustment to the demands of everyday living.

In order to measure physical fitness, the general concept must be analyzed into its various elements. Summarizing a survey of the literature, these aspects may be listed as follows: endurance, strength, flexibility, relaxation, body control, agility, freedom from disease and defect, organic soundness, cardiovascular-respiratory efficiency, motor skills, nutritional status, and morale.

STATEMENT OF THE PROBLEM

The purpose of this study is to measure the effects of a physical education program, as a part of the total environment of certain college women, on some of the aspects of physical fitness. The attempt is made (1) to select those elements which can be objectively measured in large groups with a minimum of time and equipment; (2) to select or construct usable tests of these aspects; and (3) to administer these tests to college women at the beginning and end of a semester of physical education activity to discover whether or not any

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significant change in their status has occurred as a possible result of that activity.

DEFINITION OF ASPECTS TO BE TESTED

The aspects selected for testing in this study are as follows: endurance; abdominal, arm, arm- and shoulder-girdle and foot strengths; and agility. It is recognized that it is impossible to provide situations in which only one aspect is being tested, because these elements are all more or less interrelated as they contribute to a general status of fitness.

The degree of endurance to be measured may be considered the capacity to maintain an activity at optimum speed for a long period of time, or the ability to maintain an activity at maximum speed for a comparatively short interval. In either case an individual's endurance will depend on the ability of the body to retard fatigue, and will vary with each activity.

Strength implies the ability of the whole body or a part of the body to exert great force by means of muscular effort. Arm strength may be tested directly by measuring the amount of force the arm can exert. Abdominal and foot strength may be exhibited in exercises which involve moving the body or a part of the body with the abdominal or foot muscles, respectively. Just as it is difficult to isolate any one aspect of physical fitness, it is impossible to isolate the action of any one muscle or group of muscles.

By agility is meant the skill with which an individual controls the various parts of the body in relation to one another and to the body as a whole. It also implies efficient, rapid movement with a minimum expenditure of energy. Thus agility may be described as the ability to change body position and direction quickly and efficiently, using specific motor coordinations.

DESCRIPTION OF THE TESTS SELECTED

It is not claimed that any one of the tests selected is a pure measure of the aspect of physical fitness that is involved, but that it is believed to provide a situation in which that aspect predominates.

1. *Endurance.*—A chair-stepping test was used to measure endurance by having the subject step up and down on an 18-inch chair for 15 seconds, and after a rest of one minute, repeat the performance for 45 seconds. The endurance score was the ratio of the number of step-ups completed in 45 seconds to the number completed in 15 seconds. This test, when administered to a sample of 140 college women twice, with an interval of two days between trials, had a reliability coefficient of .946.

2. *Abdominal Strength.*—Sit-ups were selected to measure abdominal strength. The various forms were tried out experimentally,

and it was found that the easiest one to perform and to standardize is as follows. The subject's starting position is lying down on her back on a mat, legs straight and together, hands on shoulders with elbows close to the body. A partner sits at the subject's feet, holding down her ankles, and counts the number of sit-ups completed. The subject must keep moving constantly, her trunk becoming alternately vertical and horizontal. Speed is not stressed, but no pauses are allowed. The score is the number of sit-ups possible. With a sample of 140, the reliability coefficient was .936.

3. *Arm Strength.*—The pull test of arm strength requires the following equipment: an ordinary spring scale (100 pounds or more), a small pulley, a rope, and a grip handle. The lower end of the scale is fastened to the floor. The rope, securely fastened to the upper end of the scale, is run through an overhead pulley, and the handle is fastened to the other end of the rope. The length of the rope is adjusted so that the shortest girl can reach the handle from a standing position with the elbow slightly flexed. Further adjustments for taller girls may be made by slipping a bolt or wooden peg through one or more loops made in the rope.

Standing erect, with a comfortable stance, shoulders fixed, the handle above the shoulder of the preferred arm, the subject pulls down as hard as possible. There should be no flexing of the knees or hips, and the body weight must be kept evenly distributed on both feet, allowing no swaying of the body in any direction. The examiner squats with her eye at the level of the scale and reads off the number of pounds pulled. The reliability of this test was found to be .932.

4. *Arm- and Shoulder-Girdle Strength.*—This test is called push-ups, and is the modified form done from the knees. The lower legs may be held in any position that is comfortable, and the knees and hands are the only parts of the body allowed to maintain contact with the mat. The subject is not allowed to rest on the mat between push-ups, to flex the hips more than five degrees, or to let the hips sag. With the sample of 140 subjects, push-ups had a reliability of .925.

5, *Foot Strength.*—Rejecting the few tests of foot strength found in the literature as involving more leg than foot action, the Bouncing Test was devised. The subject assumes a full squat position with the arms wrapped tightly around the legs below the knees, to keep the knees from extending during the test. At the signal to go, she bounces by pushing the feet slightly off the floor, keeping in rhythm with a timer who calls numbers consecutively every half-second. If the subject loses her balance but can catch herself with her hands and get back into bouncing position without losing more than three counts, she may keep going and subtract the number of

beats she lost from her final score, which is the last number called before she stops because of fatigue. The reliability of bouncing was .787. This is probably low because of its dependence on balance, which is known to be highly unreliable for a small number of trials.

6. *Agility.*—The shortened obstacle race, as reported by Scott,[1] was used to measure agility. Scott obtained a reliability of .91 with 87 cases for two trials on successive days; with 140 college women the reliability coefficient was .89.

INTERCORRELATIONS OF THE TESTS

In order to be certain that no two of the six tests were measuring the same aspect of physical fitness, intercorrelations were computed. These ranged from .043 for push-ups and chair stepping to .411 for obstacle and sit-ups, none of them high enough to suggest discarding any test.

ADMINISTRATION OF THE TESTS

The six tests, namely, sit-ups, chair stepping, push-ups, bouncing, pull, and obstacle, were given in all of the physical education classes for women at the State University of Iowa near the beginning of the fall semester of 1943, and were repeated toward the end of the semester. All students taking the tests were registered for freshman or sophomore required physical education, and had had a medical examination by the student health service. Students who were majors in physical education, restricted from physical activity, ill, or just recovering from a severe illness were excluded from the testing program. A total of 686 women took the initial and final tests, 301 of whom were in sophomore activities meeting three times a week, and 385 of whom were in freshman activities meeting twice a week.

The tests were administered by classes, in some cases to just one class, and in some cases, to two or three classes combined. Less combining of classes was done during the final tests, for it was found that, for more than 60, it was difficult to supervise adequately and to complete the tests in one class period.

Sit-ups, chair stepping, push-ups and bouncing were given en masse, scored by partners. The individual tests, pull and obstacle, were started as the students arrived, discontinued when all were present, and finished after the mass tests were completed.

STATISTICAL ANALYSIS OF THE DATA

All classes having the same activity the same number of hours per week were grouped together for statistical study. A further combining of classes was done from a subjective estimate of similar activi-

[1] M. Gladys Scott, "Motor Ability Tests for College Women," *Research Quarterly*, 14:4 (December, 1943), p. 402.

ties and a study of homogeneity with respect to the initial tests, through the critical ratios of the means. This resulted in the following groups with their respective totals: MWF groups (sophomore classes meeting Monday, Wednesday, and Friday) consisting of Swimming (119), Recreational Sports (97), Dance (51), and Team Sports (34); and TTh groups (freshmen classes meeting Tuesday and Thursday) consisting of Swimming (115), Recreational Sports (112), Dance (49), and Team Sports (109).

TABLE I

DIFFERENCES BETWEEN MEANS ON FINAL AND INITIAL TESTS

	Sit-ups	*Chair Stepping*	*Push-ups*	*Bouncing*	*Pull*	*Obstacle*
M W F						
Swimming	+5.40	—0.015	+0.07	+13.51	+9.54	+0.129
Recreational Sports	+4.81	+0.022	+1.04	+14.30	+8.67	+1.378
Dance	+6.69	+0.022	+0.98	+14.63	+9.28	+1.043
Team Sports	+6.32	—0.018	+0.36	+14.53	+5.94	+1.174
All MWF	+5.53	+0.008	+0.55	+14.07	+8.80	+0.821
T Th						
Swimming	+7.65	+0.122	+2.53	+15.88	+6.41	+1.546
Recreational Sports	+5.80	—0.148	+1.07	+14.86	+7.25	+1.888
Dance	+3.80	+0.025	+3.39	+ 5.34	+5.94	+0.972
Team Sports	+4.24	—0.083	—0.27	+ 9.47	+4.91	+1.130
All TTh	+5.82	—0.027	+1.32	+12.43	+6.17	+1.455

Note: Plus indicates improvement from initial to final test. Minus indicates loss from initial to final test.

TABLE II

CRITICAL RATIOS BETWEEN FINAL AND INITIAL TESTS FOR ALL GROUPS

	Sit-ups	*Chair Stepping*	*Push-ups*	*Bouncing*	*Pull*	*Obstacle*
M W F						
Swimming	3.68+	0.38—	0.08+	5.10+	9.73+	0.52+
Recreational Sports	3.41+	0.44+	0.99+	3.29+	8.10+	4.75+
Dance	4.26+	0.31+	0.91+	3.12+	6.03+	0.09+
Team Sports	2.68+	0.26—	0.19+	1.51+	3.81+	2.06+
All MWF	6.66+	0.40+	1.00+	6.37+	13.75+	4.83+
T Th						
Swimming	5.50+	3.05+	2.84+	4.63+	6.10+	5.74+
Recreational Sports	3.87+	3.70—	1.20+	4.06+	7.40+	6.74+
Dance	1.48+	0.42+	2.97+	1.08+	3.54+	2.03+
Team Sports	3.05+	1.66—	0.29—	3.00+	4.55+	4.04+
All T Th	7.73+	1.35—	2.81+	6.76+	10.83+	9.70+

Note: Plus indicates that ratio favors the final test. Minus indicates that ratio favors the initial test.

The mean scores for each of the above groups on the initial and final tests were computed. The critical ratios of all possible comparisons of groups on the initial tests indicated a reasonable amount of homogeneity of all sub-groups. Therefore, from this point of view all MWF groups could be combined and all TTh groups could be combined, but it was considered advantageous to study the results

of the sub-groups as well. A study of the critical ratios between MWF sub-groups and TTh sub-groups, based on the final test means, showed that there were no significant differences between MWF and TTh for any activity. A similar study of the mean scores on the final tests for the activity groups within MWF and TTh likewise indicated no significant differences between activity sub-groups.

Table I presents the differences between the means on the initial and final tests for all groups and tests. Table II presents the critical ratios between final and initial tests for all groups and tests.

Almost all groups showed a significant improvement in sit-ups; no reasonable explanation could be found for the lack of such for Team Sports MWF and Dance TTh. The apparent greater improvement shown by TTh groups might be attributed to greater response to motivation or greater capacity for improvement on the part of freshmen women.

For chair stepping, only two groups showed a significant critical ratio, one in favor of the initial test and one in favor of the final test. Since there are only two of these, and they are in opposite directions, they are not impressive, and it is reasonably safe to conclude that they are chance differences. There is considerable reason to doubt the validity of this test, for the instructors felt that their students had improved in the kinds of endurance necessary for the different activities.

No significant improvement was shown by any group in push-ups. This may be partially due to the fact that performances were more closely supervised during the final tests, resulting in lower scores for many who had probably performed the push-ups incorrectly during the initial tests. The two groups which showed almost significant critical ratios, namely Swimming TTh and Dance TTh, were tested in smaller groups during the initial tests than were the other sub-groups, and therefore probably performed the push-ups correctly at that time.

For bouncing and pull, almost all groups showed significant improvement. These are performances which could be greatly influenced by familiarity and practice, but an interval of three months between tests should have nullified that influence. No reasonable explanation could be found for the lack of significant improvement in bouncing for Team Sports MWF and Dance TTh.

The TTh groups showed a much greater improvement in obstacle than did the MWF groups. A great amount of improvement in agility was not expected, because an individual quickly reaches her limit on an activity of this type. The sophomore women had performed this test on an average of three times during their freshman year and had probably reached this limit by the time of the initial

tests. The freshmen women were performing the obstacle for their first and second times in this testing program and therefore were probably more capable of improvement.

In order to obtain a further evaluation of the various physical education activities and the number of class periods per week, the methods of analysis of variance, applied to a simple factorial design, were used. In this design the two factors were activities and hours per week, and all conclusions are, of course, applicable only to the university in which the experiment was conducted. Each of the six tests was analyzed separately, considering each one as an independent factorial design, and the differences between final and initial test scores were the bases for analysis. This analysis may be summarized as follows:

1. For sit-ups, chair stepping, push-ups, and bouncing, no activity was significantly superior to the others, and neither MWF nor TTh showed conclusive evidence of superiority, either as a whole, or in combination with any particular activity.

2. For pull, there was conclusive evidence of the superiority of MWF for all activities, and of Swimming and Recreational Sports to Team Sports.

3. For obstacle, there was conclusive evidence of the superiority of Swimming TTh to Swimming MWF; within MWF, superiority of Recreational Sports, Dance, and Team Sports to Swimming; and within TTh, superiority of Recreational Sports, Dance, and Team Sports to Swimming, and superiority of Recreational Sports to Dance and Team Sports.

The analysis of variance brought out the superiority of MWF over TTh in the pull test, a fact which was not clearly disclosed by the study of critical ratios. The lack of evidence found in the analysis of variance for superiority of any groups in sit-ups, chair stepping, push-ups, and bouncing suggests that the differences noted in critical ratios for these tests may only be chance differences. The results of analysis of variance and study of critical ratios for the obstacle test are in fairly close agreement, indicating a considerable variation among groups in differences between final and initial performances. As is suggested by a comparison of critical ratios, the analysis of variance found significant differences in obstacle improvement between MWF and TTh only for Swimming TTh.

CONCLUSIONS

The first two purposes of this study were to select those aspects of physical fitness which could be objectively measured, and to select or construct tests of these elements which could be used satisfactorily in a mass testing program. The following statements summarize that procedure.

1. The aspects of physical fitness selected for testing were abdominal, arm, arm- and shoulder-girdle, and foot strengths; endurance; and agility.

2. Sit-ups were used to measure abdominal strength; this test was accepted as valid for this purpose and was found to be highly reliable.

3. Arm strength was measured by the pull test, which was highly reliable and was found valid in a previous study and by subjective analysis.

4. Knee push-ups constituted the test of arm- and shoulder-girdle strength; this test was reliable, but valid only when form could be carefully watched. It was found to be very difficult to administer en masse.

5. Foot strength was measured by bouncing, a fairly reliable test; there is no evidence of its validity, only the writer's subjective opinion of its worth.

6. Chair stepping, using 15- and 45-second intervals, was the test used to measure endurance. Its validity is uncertain, and it was highly reliable with a random sample of 140 subjects, but apparently less consistent when performed by 686 subjects.

7. Agility was measured by a short and simplified obstacle race, the validity and reliability of which had been established in previous research studies.

The third part of this study dealt with the administration of these six tests to 686 college women as a further check on the value of the tests, and to determine the changes in status over a three-month period, during which time the women participated in physical education activities two or three times per week. The following statements concerning the tests, the status of various groups, and the relationship of physical education to this status are based on evidence presented in the study.

1. An overall improvement was found in sit-ups, pull, bouncing, and obstacle, in spite of the fact that there was a considerable amount of illness among students immediately preceding the final tests. A far greater improvement may have resulted had there been less illness, for many individuals known to have been in good health showed great improvement, while many others who were recuperating from illness were unable to maintain their original status.

2. Participation in physical education is suggested as one factor in the total environment of these college women which contributed to the general improvement. Other possible factors include outside activities or work, increased motivation and interest in the final tests, familiarity with the tests, and other extraneous factors in the total background that were beyond control.

3. There was no conclusive evidence to suggest the superiority of any one type of activity in its effect on improvement in status for any of the tests.

4. Only for pull was there evidence to suggest the superiority in effect of three periods per week of activity as compared with two periods per week. The apparent superiority of two periods per week in obstacle was attributed to lack of previous experience with the test.

5. The results for chair stepping and push-ups showed little evidence of general improvement. They cannot be offered as an indication of the subject's performances in endurance and arm- and shoulder-girdle strength, respectively. With closer supervision of form, it is possible that further experimentation with these tests might provide results similar to those for the other four tests.

6. The study as a whole presents valuable information regarding the performances of a large selected group of college women on the tests of abdominal, foot and arm strengths, and agility. Other departments of physical education for college women may find them useful for determining the status of their students in these aspects of physical fitness.

7. Further research is indicated for the measurement of endurance, using other tests as well as chair stepping, and of arm- and shoulder-girdle strength, using push-ups and similar tests of the same muscle groups, as well as for the measurement of other aspects of physical fitness not included in this study.

FURTHER USE OF THESE TESTS

The six tests were repeated in all physical education classes for women at the State University of Iowa in April, 1944, two weeks before the end of the semester. This testing program was subsequent to the completion of the original study, and the results given here do not appear in the dissertation. There were 562 college women who performed the tests three times, namely, September, 1943, December, 1943, and April, 1944.

The Tuesday-Thursday classes showed a slight improvement in sit-ups, bouncing, and pull, and a statistically significant improvement in obstacle, from December to April. They showed a slight loss in push-ups and a significant loss in chair stepping. The Monday-Wednesday-Friday classes showed a slight improvement in sit-ups, push-ups, bouncing, and pull, and a significant improvement in obstacle. They showed a slight insignificant loss in chair stepping. There was a general overall improvement in bouncing and obstacle, although it did not reach statistical significance in all activity groups. Performance in the other tests was not consistently better or poorer in April than in December, with the exception of a small class in physical fitness, in which the students practiced activities similar to

many of the tests throughout the semester and were highly motivated during the April tests.

Summarizing a study of September to April changes, in sit-ups, push-ups, bouncing, and pull, the gains took place mostly during the first semester. This may have been due to less motivation in April than in December, or to the fact that the potential limit of gain may have been reached by many in December.

After three administrations of the tests, it was concluded that sit-ups, bouncing, pull, and obstacle are useful tests of their respective aspects of physical fitness, as they were administered in this study. Push-ups must be administered individually instead of en masse in order to measure accurately arm- and shoulder-girdle strength. Chair stepping, as administered in this program, is not a valid test of endurance; further research is needed in this field.

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1 Katherine B. Crisp, *Health for You*, p. 520. (books)

2 Stern, Frances. *Applied Dietetics*. Baltimore: Williams and Wilkins Company, 1943. Pp. x plus 29. (books)

3 Corbin, H. D., "Current Problems in Recreation," *Journal of Health and Physical Education*, 15:6 (June, 1944), pp. 315-16, 353-54. (magazines)

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Colorado: Granville Johnson
Conn.: Herbert Walker, Marjorie Zang
Dance: Ruth Bloomer
Delaware: G. W. Ayars
Delta Psi Kappa: Margaret McCall
Dental Health: Randolph G. Bishop
District of Columbia: Isabel Chappell
First Aid and Safety Education: Irma Gene Nevins
Florida: Katherine Montgomery
Georgia: Thomas McDonough, Gertrude Manchester
Health Instruction: Rosemary Kent
Idaho: (None)
Illinois: Richard Baxter, C. O. Jackson, Salen Herke, Ray Duncan
Indiana: John Scannell, Carolyn Bookwalter
Industrial Recreation: John Ernst
Institutional Recreation: (To be appointed)
Intramural Athletics: Milton R. Howard
Iowa: Gladys Scott, Roscoe Abbett
Kansas: Edna McCullough, Oran Shearer
Kentucky: Mary May Wyman
Louisiana: Frank J. Beier, Jess W. Hair
Maine: Louis Hutto
Maryland: Louis R. Burnett
Massachusetts: Ruth Evans, Nelson Walke
Men's Athletics: Everett S. Dean
Mental Health: Alfred Kamm
Measurement and Evaluation: Don Minnegan
Michigan: Margaret Bell, Vaughn Blanchard
Minnesota: Harold K. Jack, Glen Galligan
Mississippi: John J. Read
Missouri: Helen Manley, Ruth Ann Frasier
Montana: (None)
Municipal Recreation: (To be appointed)
National Association of P. E. for College Women: Elizabeth Halsey
National Col. Ath. Assn.: F. W. Luehring
Nebraska: James Lewis
Nevada: (None)
New Hampshire: Maurice O'Leary
New Jersey: Arthur Morr, Margaret Millar
New Mexico: Jere K. Reid
New York: Ellis Champlin, H. Harrison Clarke, Francis Moench, William Boyle, Ethel T. Kloberg
North Carolina: Julia Grout
North Dakota: Louise Reishus
Ohio: Delbert Oberteuffer, John Van Why, Paul Landis
Oklahoma: Art Griffith
Oregon: Lestle Sparks
Park Recreation: Milo P. Christiansen
Pennsylvania: C. Lawrence Walsh, Lloyd M. Jones, G. W. Mueller
Phi Delta Pi: Bernice Moss
Phi Epsilon Kappa: Wilbur DeTurk
Phys. Educ. Society of the Y.M.C.A.'s of N. A.: M. L. Walters
Private Recreation: Harold L. Kistler
Private School P. E.: T. John Johnson
Professional and Public Relations: Jessie R. Garrison
Professional Education: Mabel Rugen
Public School Physical Education: Joseph Burns
Research: Karl W. Bookwalter
Rhode Island: Bessie H. Rudd
School Nursing: Mildred Coyle
School Nutrition: Melva Bakkie
School Physicians: Charles C. Wilson
School Recreation: Carl A. Troester
Society of State Directors: Frank S. Stafford
South Carolina: Alice Dent Brodies
South Dakota: (None)
Student: Lucille Brahms
Tennessee: Bernice Iddins
Texas: Frances Wayman, Donnie Cotteral
Therapeutics: Mrs. Ivaleare S. Howland
Utah: Leona Holbrook
Vermont: Alice C. Aldrich
Virginia: Martha Barksdale, E. V. Graves
Washington: J. Spencer Reeves, Edwin A. Graham
West Virginia: Randolph Webster
Wisconsin: William C. Pickett, Jane E. Whitney
Women's Athletics: Anna Espenschade
Wyoming: (None)
Y.W.C.A. Health Education Directors Society: Edith M. Gates